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Intercept: Crafting a Live-Action VFX Short Film with Limited Resources

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Intercept:
Crafting a Live-Action VFX Short Film with Limited Resources

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by
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Accepted by:
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Abstract

This thesis describes *Intercept*, an ongoing science-fiction short film production, involving the integration of a fully computer-generated character, as well as other digital effects, within a live-action setting. The thesis encompasses all aspects of the filmmaking process: from conception, design, and development, to the execution of principal photography, and into post-production. This endeavor is inspired by the work of Sam Gorski and Niko Pueringer of CorridorDigital, Ferand Peek, and Neill Blomkamp, in their exemplification of the ever-increasing ability of contemporary filmmakers to craft high-fidelity visual effects, within a live-action context, in spite of limited access to resources such as equipment, personnel, and finances. The narrative was developed from the concept of a futuristic thief and his accomplice, a robotic dog, attempting to infiltrate and escape from a secure facility. The pre-production and production of the film have thus far spanned approximately eight months, and have involved a small cast and crew of student volunteers from multiple disciplines, collaboration with other university departments, and crowd-funded financial support.

Acknowledgments

First and foremost, I want to express my thanks to my wife, Alyssa, for her loving and unwaivering support and encouragement.

I would like to thank my family, for instilling the work ethic and confidence to pursue all endeavors wholeheartedly, and also my friends: Jon Barry, for graciously sharing his knowledge of Houdini and FX in general; Dylan Swift, for his invaluable modeling experience and the sacrifice of his time; and Karl Jahnke, for his camaraderie, for challenging me to explore my creativity, and for selflessly assisting as part of the crew.

I would like to thank the cast and crew: Chris Berry, Christian Stith, Horace Priester, Summer Benton, and Caroline Bryant, for generously volunteering their time and effort. I would also like to thank all the Kickstarter backer for their financial support, especially Gina Guererro, for her contribution as an executive producer.

Finally, I would like to thank my committee: Dr. Donald House, for his guidance, both in this endeavor and throughout my academic career, and for encouraging me to pursue my passions; Tony Penna, for his advice and facilitation of the collaboration with the Performing Arts Department; and Dr. Brian Malloy, for his positivity and constant dedication to the educational wellbeing of his students.

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1 Introduction

While I have always had an affinity for various forms of artistic expression, my first endeavors in filmmaking began simply in high school when I taught myself to edit using Windows Movie Maker. I would gather clips from film trailers on YouTube and edit them to music or audio clips from other trailers. Through these unassuming projects I began to understand timing. Soon this developed further into narrative work with an extra credit project for a high school class. Working with three classmates as actors and an inexpensive point-and-shoot still camera, I filmed and edited a 23-minute short film. This experience sparked a passion for filmmaking that has remained with me and influenced my creative endeavors ever since. Through the rest of high school, I continued to work on short films with friends, expanding in scope, and working to push the limits of our modest resources and inexperience. Stills from two of these projects can be seen in Figure 1.1.

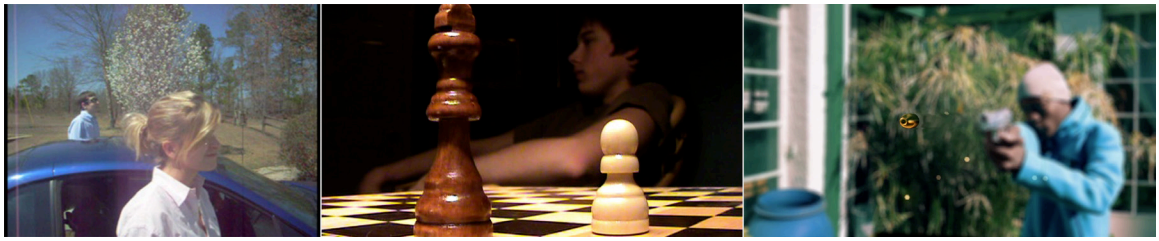


Figure 1.1: Stills from two high school film projects and early slow-motion bullet VFX

Upon entering university, filmmaking remained just a hobby, and academically I pursued another field I was enthusiastic about: computer science. However, I began to see increasing intersection between these two interests as I explored the capabilities of visual

effects by teaching myself Adobe After Effects and Blender. One of my first attempts at creating my own digital effects was a slow-motion bullet firing animation, composited onto live action footage, following a Video Copilot tutorial, a frame from which can be seen in Figure 1.1.

Inspired by the intersection of logical and creative problem solving involved in digital visual effects, I chose to pursue this further academically in graduate school. Through this I have been able to work on fully animated pieces such as *Rats* (2015), a small-group studio project about competing rats in space. However, my passion has still remained with live-action projects such as *Rift* (2014), a short film about a gamer experiencing different genres of games as virtual reality (Figure 1.2).

Figure 1.2: Stills of recent full CG animation in *Rats* and live action VFX in *Rift*

The physical limitations of filmmaking create a unique set of challenges that I have always found compelling. While purely digital effects offer an alluring, practically unlimited level of freedom, I find it rewarding to find creative ways to overcome the physical limitations of live-action filming. Much of this mindset has been heavily influenced by the

filmmakers and visual effects artists Sam Gorski, Niko Pueringer, Ferand Peek, and Neill Blomkamp.

Figure 1.3: Stills from the *Modern Warfare: Frozen Crossing* shorts, by RocketJump and CorridorDigital [4] [5]

I began following Sam Gorski and Niko Pueringer in 2010 after seeing the series of YouTube short films, *Modern Warfare: Frozen Crossing*, which they directed based on the *Call of Duty* video game series. I was immediately intrigued by the work they were doing, crafting high fidelity visual effects with limited resources. Figure 1.3 shows stills from two of the shorts, which demonstrate the use of props and VFX to effectively convey an action setting. Not only did they begin to release more and more shorts, but they maintained an open and informative nature about their work, giving insights into how they were creating. This was a huge learning experience for me as I followed their YouTube channel and growing VFX company, CorridorDigital over the years, as it expanded my views on how to approach filmmaking and use creative problem solving to achieve complex filmmaking feats. In addition, CorridorDigital has always been focused content creation and sharing, and through this they are always taking advantage of emerging technology and trying new things. This has encouraged me to question existing artistic and creative methodologies, as I believe that an artist should always be evaluating and re-evaluating how they are solv-

ing problems, and be willing to try new tools and understand when a different way works better.

Figure 1.4: Still from Ferand Peek's *Mis-drop* [6]

Ferand Peek is a filmmaker and visual effects artist from New Zealand. I was first exposed to his work during an internship in the summer of 2014 when a link to his short film *Mis-drop* (2013) popped up in an email thread. In this short, Peek was able to craft a high-concept, gripping science fiction narrative, by embracing his limitations, and crafting a story which could be told almost exclusively from a single medium close-up of a character's face. He ingeniously reworks this constraint to form the crux of the narrative, limiting the view of the audience and evoking a claustrophobic atmosphere while using lighting and reflections to convey the setting, as can be seen in as still from the short, Figure 1.4. Another significant inspiration was Peek's dedication and exertion of the patience and

effort necessary to fully realize his vision. After filming the short, he spent six months teaching himself compositing in order to convey enough of his vision to help get other people on board and in the end the short took four years from writing to final realization [8]. This dedication to craft reminds me that these types of projects can be immensely personal endeavors, and ultimately they deserve the dedication to see them through.

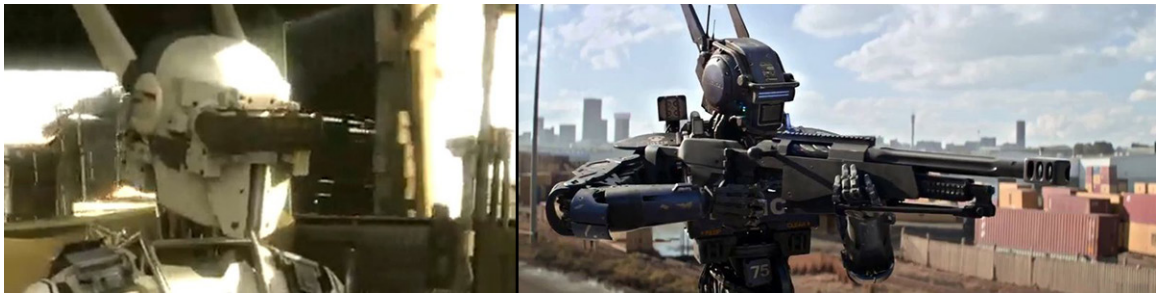


Figure 1.5: Comparison of stills from *Tetra Vaal* [1] and *Chappie* [7]

Figure 1.6: Comparison of stills from *Alive in Joburg* [2] and *District 9* [3]

Neill Blomkamp is a South African filmmaker who is known for his cinema verite style, and his seamless integration of tangible digital effects. While I particularly enjoy his particular visual style of science fiction, one of the things that has influenced me is the how distinct his artistic vision is within his work. Two of his major feature films

thus far, *District 9* (2009) and *Chappie* (2015) are based on his earlier short films *Alive in Joburg* (2005) and *Tetra Vaal* (2004), respectively. Regardless of the scope of the project, Blomkamp maintains his own sense of creative vision; whether under the constraints of low-budget filmmaking or with access to greater resources, he maintains a personal creative vision. And ultimately he did not let his limitations stop his short film endeavors, as even then he was attempting to create things on a similar scope to his big-budget productions now, which can be seen in the comparisons of the films shown in Figure 1.5 and Figure 1.6.

All these filmmakers take an approach of not viewing limitations as obstacles to be overcome, but as opportunities to be embraced, and creatively used to reinforce the existing artistic vision. It is this fundamental idea that has fueled my work. Throughout this thesis, most decisions I have made serve a two fold purpose: to address some technical or practical limitation while also serving the narrative and artistic vision.

2 Pre-Production

The process of pre-production for *Intercept* spanned approximately four months. This involved all aspects of design and development for the short, from initial conception, design, research and development, to asset fabrication.

2.1 Story

In all aspects of developing and writing the story, I wanted to push my own limits creatively, yet I had to remain conscious and aware of what remained practically realistic. I knew that I would not be able to use large numbers of actors, so maintaining a limited amount of characters was important, though I knew this would help the narrative remain character-centric. I also did not know what type of location I would be able to find, and thus tried to keep aspects of the story flexible to suit the eventual location. Time was also a factor I knew I would be constantly pushing against. With this awareness, I set about developing a story.

I have always been heavily influenced by science fiction, as a genre. I am fascinated by unique and intriguing technology, and the freedom of science fiction to be creative beyond the bounds of realism. However, I feel that science fiction also has an immense capacity to remain grounded, and still create a believable environment and atmosphere.

Initially I envisioned an element of stealth in the story, mainly because the character I was imagined was more of a rogue. This evolved into another dual-purpose decision

as, importantly, a narrative centered around stealth would have a practical reason for not having more than two characters present in any given scene. While considering aspects of a futuristic setting, I began thinking of the increasing digital nature of commodities in our modern world, and what that would look like when the concept of "ownership" can be applied to patterns of 1s and 0s. This led to the idea of the character being a futuristic thief, stealing information.

The story grew from a core, character-centric concept: to depict a relationship of teamwork and dependency that would ultimately be torn apart by the characters themselves. Ultimately this boils down to the concept of a Greek tragedy, in which a character's demise or downfall is brought about by a tragic flaw; a downfall which does not evoke a sense of justice, but pity. This characterization is described in Aristotle's description of tragedy:

> *"There remains, then, the character between these two extremes- that of a man who is not eminently good and just, yet whose misfortune is brought about not by vice or depravity, but by some error or frailty" [9]*

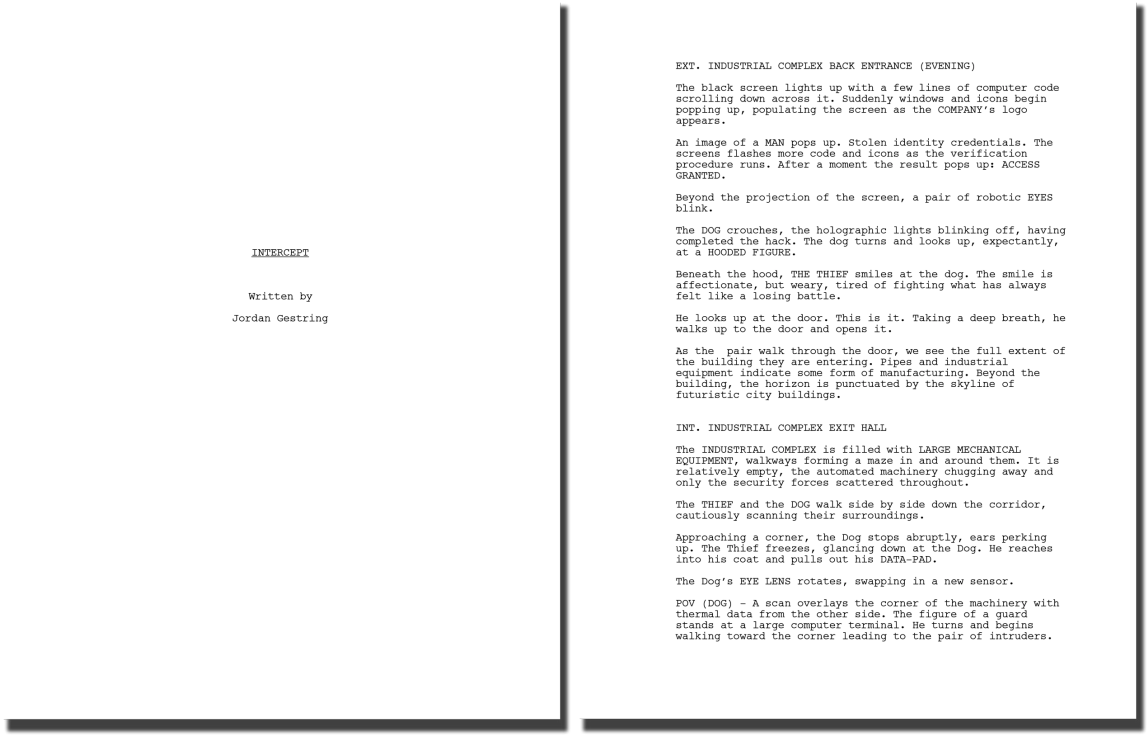
In addition to the relationship between humans and robots being a prevalent theme throughout science fiction, I wanted to try and realize a fully digital character as part of challenge of the visual effects. I chose for the robot to be a dog because of the species' close historical bond with humanity, and how that could logically filter into the design of robots in a futuristic society. Though it was especially because of the characteristics of loyalty associated with dogs. Ultimately I wanted the tragic consequences of the narrative to be the result of a two-fold set of flaws: the Thief's selfishness which sets the

events in motion, and the Dog's unwavering loyalty, which leads to a sacrifice which, while well-intended, is ultimately in vain.

When I had the basic setting of the story in place, I developed the structure with a very simple outline of the story arc:

- The Thief and Dog break into an industrial complex to steal information.
- The pair work together to neutralize guards and reach their target in stealth.
- When they reach their goal, the Thief finds a shiny piece of technology. In his greed he carelessly sets off an alarm.
- The pair try to escape the complex; but in order to save the Thief the Dog sacrifices himself.

From this, I fleshed out the outline by walking through each broad aspect of the story in a shot-by-shot manner. As a part of this I developed a list of potential "gags", small set pieces, and specifically VFX moments that could work within the story. The goal was to develop elements that are born organically from the narrative, and not try to shoehorn in something that is out-of-place.



INTERCEPT

Written by

Jordan Gestring

EXT. INDUSTRIAL COMPLEX BACK ENTRANCE (EVENING)

The black screen lights up with a few lines of computer code scrolling down across it. Suddenly windows and icons begin popping up, populating the screen as the COMPANY's logo appears.

An image of a MAN pops up. Stolen identity credentials. The screens flashes more code and icons as the verification procedure runs. After a moment the result pops up: ACCESS GRANTED.

Beyond the projection of the screen, a pair of robotic EYES blink.

The DOG crouches, the holographic lights blinking off, having completed the hack. The dog turns and looks up, expectantly, at a HOODED FIGURE.

Beneath the hood, THE THIEF smiles at the dog. The smile is affectionate, but weary, tired of fighting what has always felt like a losing battle.

He looks up at the door. This is it. Taking a deep breath, he walks up to the door and opens it.

As the pair walk through the door, we see the full extent of the building they are entering. Pipes and industrial equipment indicate some form of manufacturing. Beyond the building, the horizon is punctuated by the skyline of futuristic city buildings.

INT. INDUSTRIAL COMPLEX EXIT HALL

The INDUSTRIAL COMPLEX is filled with LARGE MECHANICAL EQUIPMENT, walkways forming a maze in and around them. It is relatively empty, the automated machinery chugging away and only the security forces scattered throughout.

The THIEF and the DOG walk side by side down the corridor, cautiously scanning their surroundings.

Approaching a corner, the Dog stops abruptly, ears perking up. The Thief freezes, glancing down at the Dog. He reaches into his coat and pulls out his DATA-PAD.

The Dog's EYE LENS rotates, swapping in a new sensor.

POV (DOG) - A scan overlays the corner of the machinery with thermal data from the other side. The figure of a guard stands at a large computer terminal. He turns and begins walking toward the corner leading to the pair of intruders.

Figure 2.1: Screenplay excerpt showing description of the first scene

With the general narrative structure fleshed out, I drafted a screenplay. This contained descriptions of location and atmosphere as well as the details of the story, but most importantly, this puts the narrative in a structure that is more useful for the actors to work with. The first page of this can be seen in Figure 2.1. Next I developed rough storyboards for the narrative beats and types of shots that were part of my artistic vision. This was important to explore the progression of the film, in order to visualize and evaluate how scenes would actually play out and also see where visual effects would fit in. However, without a determined location for filming yet, I knew that many of these ideas would have to be adapted depending on the physical limitations of the available space, so I kept the details of the boards generic enough to maintain a flexible mindset.

A selection of these rough boards can be seen in Figure 2.2. The opening scene is portrayed in Panels 1-3, with the Dog and the Thief outside of the facility, as the Dog interfaces with the electronic lock using a holographic HUD (Panel 1), and the establishing shot shows the futuristic city in the background. Next, in Panels 4-8, the pair progress down corridors when the Dog uses his sensor vision (Panel 7) to detect the first guard patrolling. In Panels 9-14, the pair approach the central server room, steal the data, and are about to leave when the Thief is captivated by the mysterious tech. Panels 15-17 portray the beginning of the altercation with the second guard, including the shielding effect which the Thief uses to defend himself (Panel 16). Finally, Panels 18-20, portray the ending of the film, when the Dog sacrifices itself, and the Thief is brought to ruin. In general, the plain background seen in these boards allowed the blocking of action and composition of shots to be described independent of the actual scenery, while color was used to easily identify the visual effects.

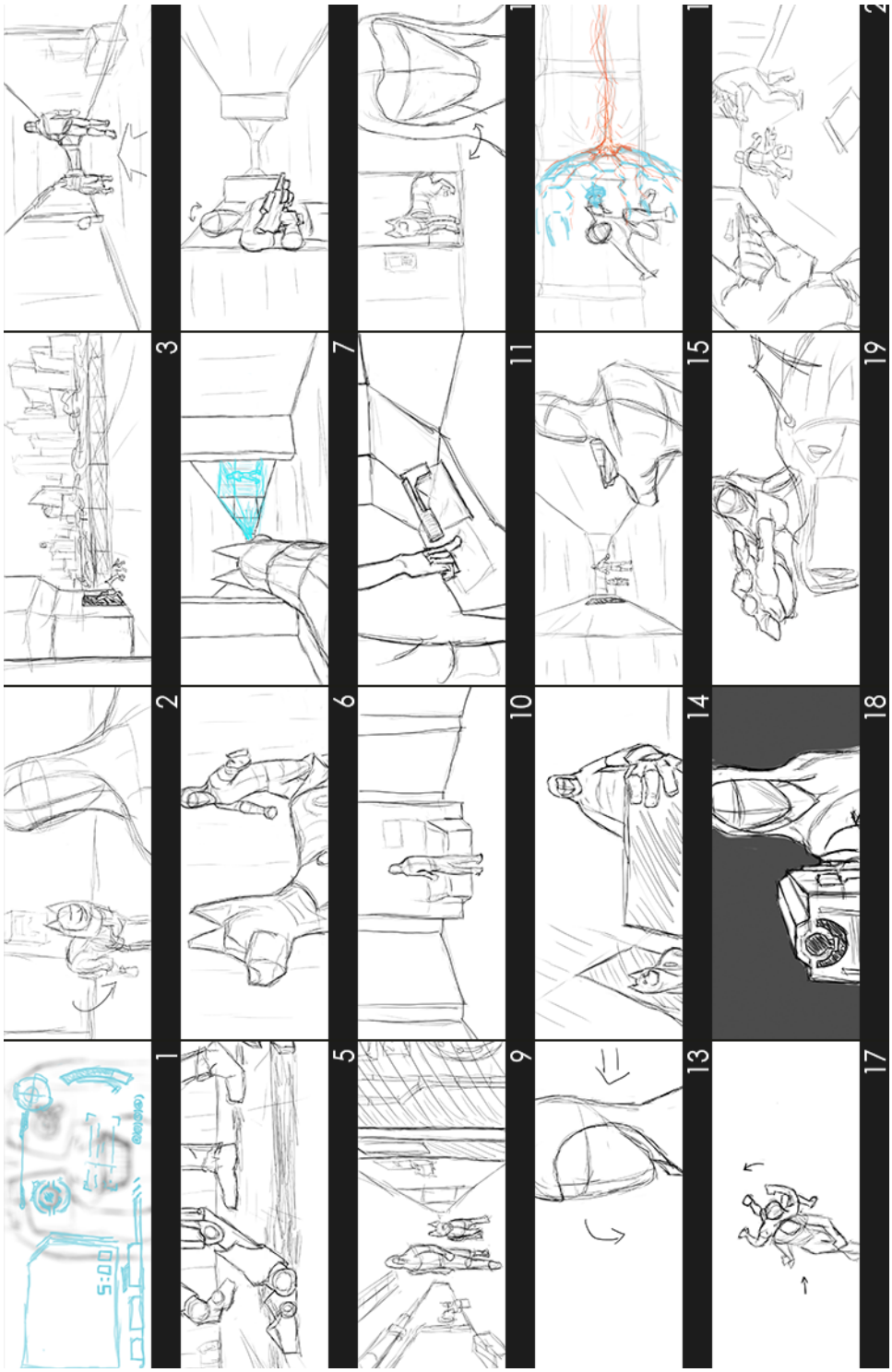


Figure 2.2: Selected storyboards

2.2 Look Development

After the basic story concept was in place, I began working on designing all the aspects of visual look development. However, as with the story, I had to maintain a mindset of flexibility about what would be feasible. For example I could not design detailed sets, as it was beyond my budgetary abilities to build sets and instead I would have to work with whatever was available at the location.

So instead of designing too many specifics in regards to the environment, I researched the feel and atmosphere that I wanted to create. With that in mind, any location with similar physical characteristics to what I envisioned could be utilized to convey that atmosphere. I generated various pieces of concept art in order to explore my general design ideas for the film. Additionally, this provided resources for me be able to better convey my vision to others, and would be invaluable later on in production when communicating with crew and actors.

Figure 2.3: Test Matte painting

Some examples of this are a test matte painting that I created from a photograph of my apartment (Figure 2.3), to demonstrate my vision for the setting, and character concept art (Figure 2.4), to help visualize the style I was going for.

Figure 2.4: Early character concept art

2.3 Character Development

The character of the Dog is a significant aspect of the story as a whole, and convincingly executing this would require a high level of fidelity. Being able to focus on a single digital asset allowed this part of the production to receive the necessary amount of investment, even while being executed almost completely by a single artist.

2.3.1 Design

On of the most important aspects of any task is research. With this mindset, I began designing the Dog by researching canine skeletal structure, anatomy, and physiology. One of my goals for the character was to make sure that, despite being a robot, the audience would be able to immediately recognize and relate to it as a dog. I aimed to imitate distinct aspects of form and personality in order to remain familiar enough so as not to distance the audience emotionally from the character, and to also keep the Thief's bond believable.

In addition, I researched as many aspects of mechanical design as possible, ranging from real, practical modern robotics, to futuristic concept art. My goal with the mechanical aspects of the character was to design something that felt futuristic, but still maintained a believability as something that could exist in the near future. In this sense I wanted all the mechanical aspects to feel functional and grounded in real-life engineering.

The initial design process started with sketches of various potential designs, which I could scan and digitally paint in *Photoshop* as seen in Figure 2.5. There were a few as-

pects of the character that I envisioned from the beginning, such as a sort of plated, but sleek design, reminiscent of body armor. Exploring variations on this idea allowed me to hone in on what felt cohesive and what did not.

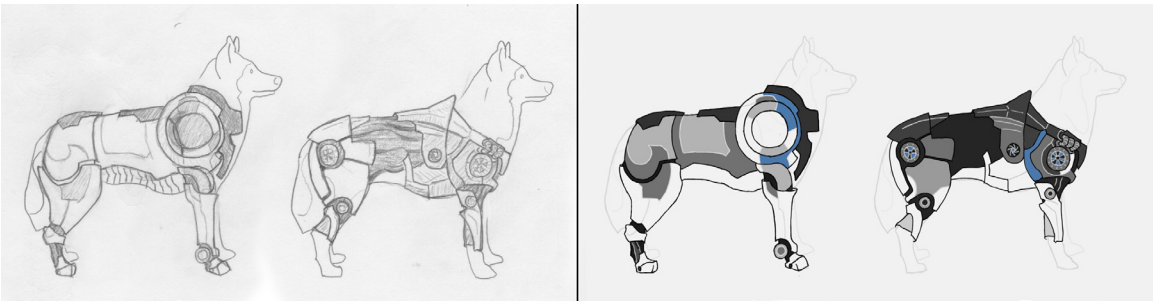


Figure 2.5: Initial design exploration sketches and digital paintings

In the process of researching different aspects of design, a fellow student showed me the music video for the song *Greyhound,* by Swedish House Mafia. In the video, three color-coordinated groups of extravagantly-clad observers gather on a vast salt flat to watch a race between three remote-controlled robotic dogs. I found this to be a helpful example of the type of tangible design I was exploring, as well as photorealistic integration of a digital character. However, the main aspect that influenced me was how the character designs maintained a mechanical form, yet were still able to capture the distinct physical appearance of specific breed of dog, greyhounds, as shown in Figure 2.6.

Figure 2.6: Still from the music video for *Greyhound* by Swedish House Mafia, directed by Carl Erik Rinsch, VFX by Big Lazy Robot

This inspired me to use my own character to evoke imagery of a specific breed of dog, the Husky. I chose this breed because of their association with wild nature; while they physically display much more similar connections to wolf ancestry than many other breeds of dogs, they are still commonly perceived as amicable with humans. In addition, Huskies are associated with harsh conditions, and their ruggedness and ability to withstand nature fit well with the concept of the robot being used as a reconnaissance and infiltration unit, and related to the rogue-like nature of the Thief.

In addition to the basic proportions of the Husky, the most distinct physical characteristics are the various coat markings. I wanted to utilize the paint scheme and structural elements of the character to match up with these color patterns. I ended up designing the character with the concept of two "layers", a structural underlying skeleton which

would then be covered by more protective armored plates. The skeletal structure would allow for mechanisms, and moving parts, and the plates would fill in the design, as well as fit in with the coat pattern.

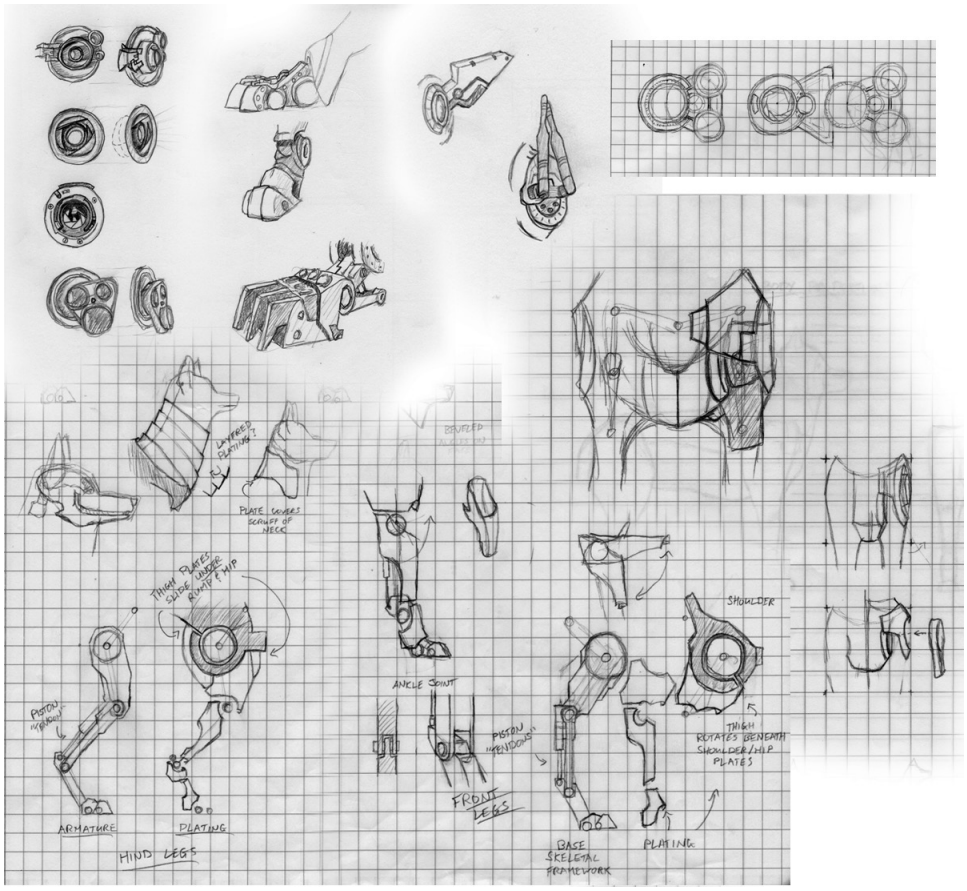


Figure 2.7: Mechanical detail designs for eyes, paws, ears, and limb joints

I chose to keep the character as mechanical as possible. This would help in its rigging and animation, as there would be very few deforming parts. However, this introduced the need to plan and design how the engineering of the character would work to make the movements appear mechanically sound. I designed many of the joints to be

exposed, better revealing the character's mechanical nature. However this required careful planning to ensure that joints had space for the necessary range of motion, and that moving parts would not interpenetrate in obviously impossible ways. For other joints on the character I was able to circumvent the need for strict mechanical integrity by covering moving parts with plates, such as in the spine, shoulders and hips. Figure 2.7 shows a variety of sketches exploring different possibilities for eyes, paws and ears, as well as joint structures for the limbs.

For the eyes of the characters, I wanted to convey the mechanical nature of the optics, so I chose to integrate camera lenses and mechanisms in the design (Figure 2.8). This included focus rings and the rotating lenses commonly seen on older camcorders. I also integrated camera aperture blades, with the goal of animating these as the character's irises to give it a sense of life, but still a distinctly mechanical appearance. Another anatomically based design was the use of hydraulic pistons as practical "tendons" in the legs. This process culminated in the creation of a final design sheet (Figure 2.9), which breaks down the mechanical components into various layers and pieces in order to provide as much information as possible for the character to be realized in 3D.

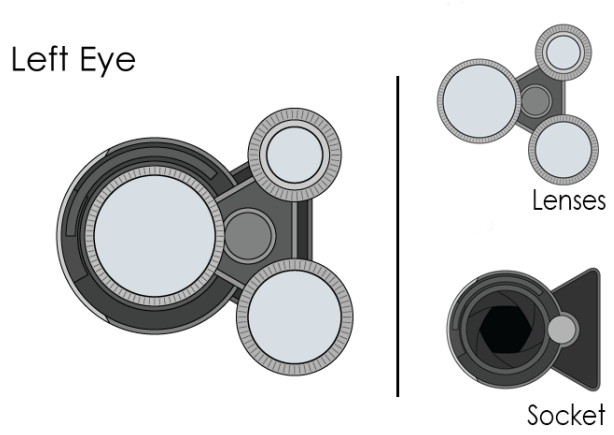


Figure 2.8: Rotating lens design for the Dog's eye

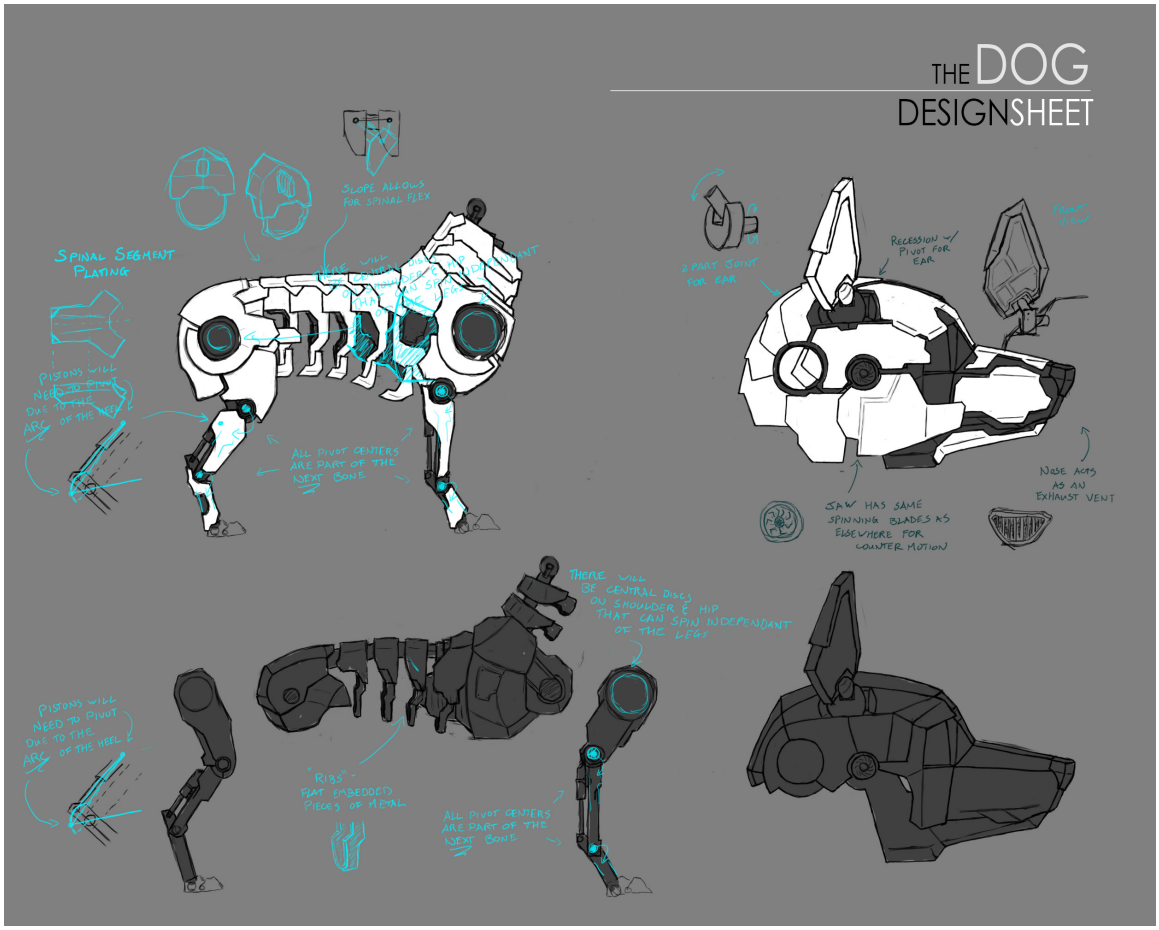


Figure 2.9: Final characters design sheet

2.3.2 Modeling

Modeling was the sole area of pre-production in which I was able to collaborate with another student artist, who also happened to be working professionally as a modeler. Ultimately he was not able to see the model through to completion, a situation which is always a possibility when collaborating on a volunteer basis, and also a prime example of the need for flexibility in development. However, he was still able to provide guidance after I took over the process, and this provided invaluable insights into techniques and workflow.

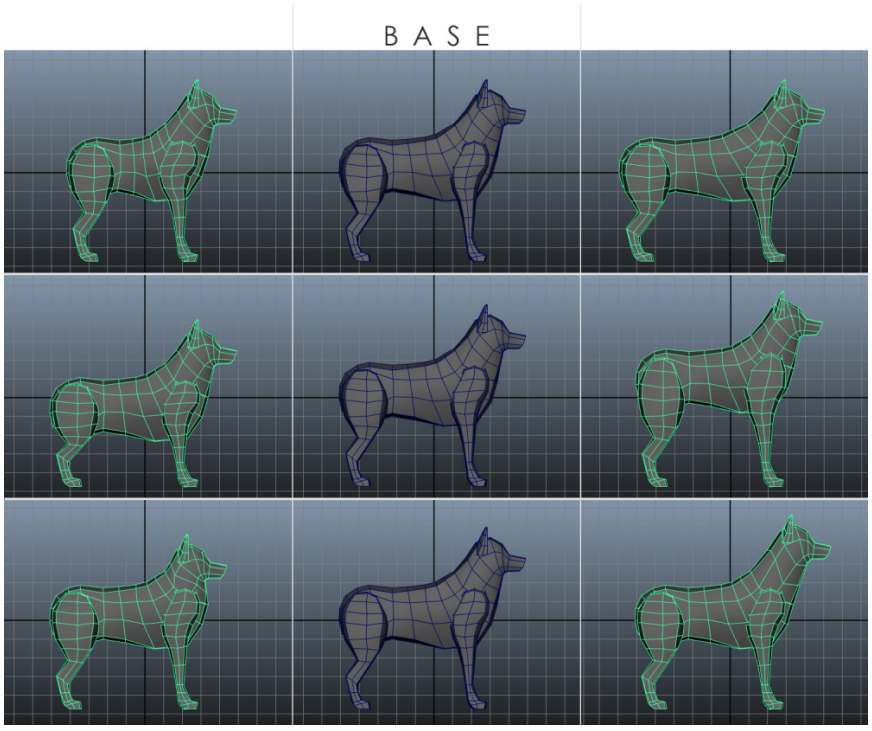


Figure 2.10: Body proportion wedges for prototyping

With the designs in place the specific body proportions needed to be decided upon. This was done by the initial modeler by creating a wedge, or a range of options for different parts of the body. This wedge can be seen in Figure 2.10, and was useful to hone in on an exact body shape that looked good in 3D and not just the 2D designs.

Hard surface modeling presents a particular set of challenges, especially when dealing with some of the complex and detailed forms that were present in my character designs. At render time, the model would make use of a subdivision scheme, so the topology needed to be constructed with that in mind. In order to maintain sharp forms this method of modeling requires the integration of holding edges. Remaining conscious of topology throughout the modeling process was integral to avoiding many pitfalls that can plague a straightforward, yet naive approach, as seen in Figure 2.11.

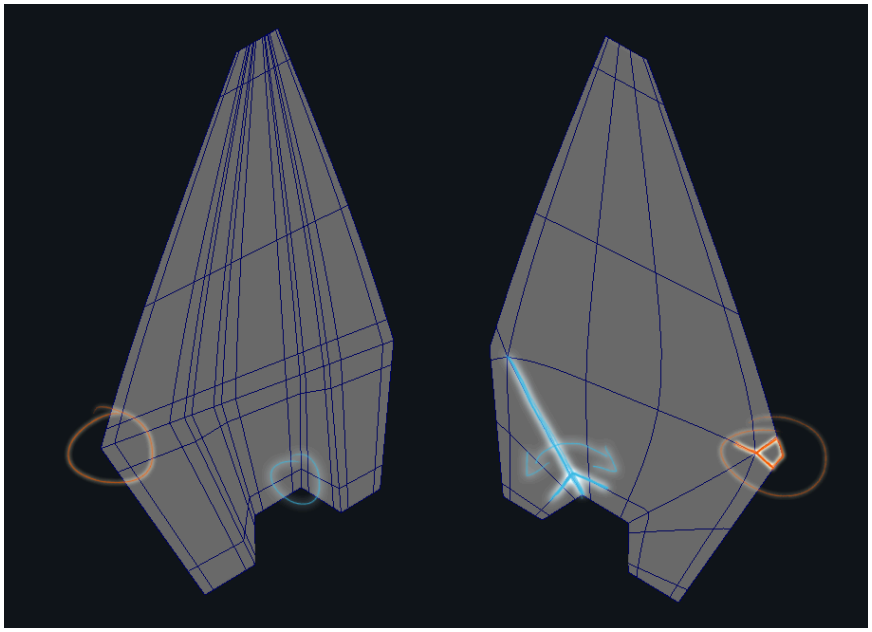


Figure 2.11: Comparison of naive topology (left) with efficient topology (right)

One useful technique is known as “kite-ing”, and involves the use of skewed quadrilaterals, shaped like kites, to hold convex corners without many edge loops that can create excess geometry or pinching on smoother planes. In general, understanding the implications of “edge flow”, is an essential element of efficient modeling, both in terms of artist time and the resulting geometry.

Since the model would be integrated with live action footage, the level of detail needed to be sufficient that the character would not jarringly stand out as a CG element. The layered design of the character helped create this level of visual complexity while still maintaining a cohesive form. In order to keep the mechanics of the character believable, I tried to maintain a sense of physical connection by, for example, creating visible pivots where mechanical joints would need to rotate on the character’s legs. The end result of the modeling can be seen in Figure 2.12.

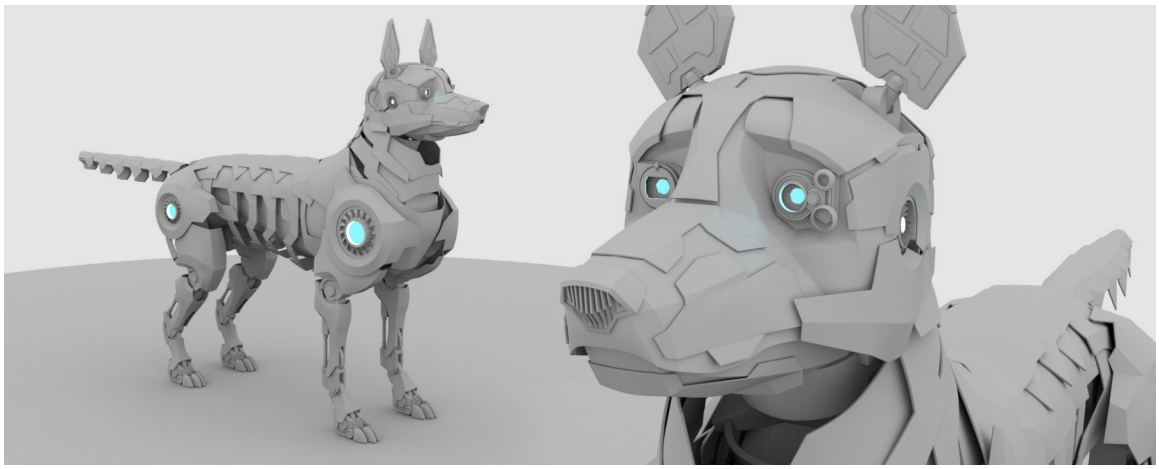


Figure 2.12: Final character model for the Dog

The final responsibility of the modeler is to perform UV unwrapping, to prepare the geometry for texturing. While segmentation of the character provided natural seams, which can be complex to manage on an organic model, the level of detail produced a high volume of individual pieces of geometry to be unwrapped. Fortunately, the mechanical design meant many pieces were topologically similar, so a single UV mapping could be applied to multiple pieces of geometry. The symmetry of the model also reduced the workload in UV unwrapping.

While *Maya* provides a workable set of UV unwrapping tools, its effectiveness is limited in comparison to dedicated UV unwrapping tools, as they can focus on excelling at a single purpose. The tool that I found to be most useful for this purpose was *UVLayout*, as it allows an intuitive workflow of managing seams and shells in both 3D and 2D UV space, as well as 3D visualization of UV distortion with colors and grids (Figure 2.13). This proved to be very effective at maintaining a fluid and efficient workflow.

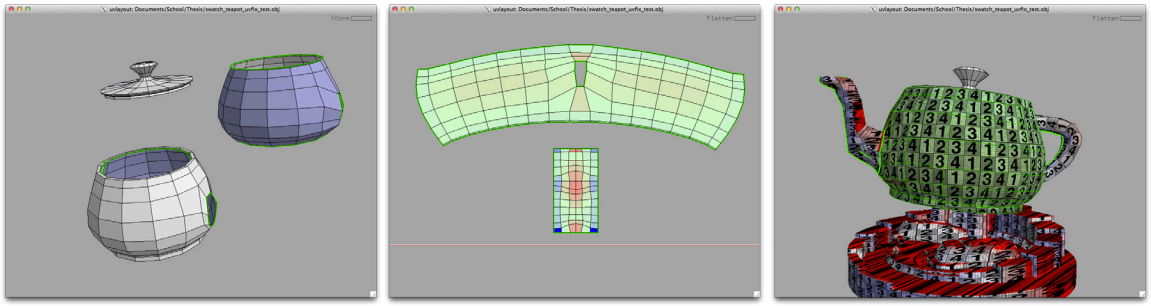


Figure 2.13: 3D and 2D shell building and distortion feedback in *UVLayout*

2.3.3 Rigging

Rigging a quadruped requires a different approach than most bipedal rigging techniques. While bipeds distribute weight only through their hips, quadrupeds do so through their shoulders as well. As such being able to pose the shoulders and hips relatively independently would be useful for animation. Many techniques that achieve this, such as ribbon spines, involve a "squash and stretch" spine. This is useful for certain applications, but since I wanted the movements of my characters to appear to remain within mechanical constraints, I needed a solution the would maintain joint spacing along the spine. The solution that I implemented was to use IK splines to control the ends of the spine, and then use cluster deformers to pose the curvature in between (Figure 2.14).

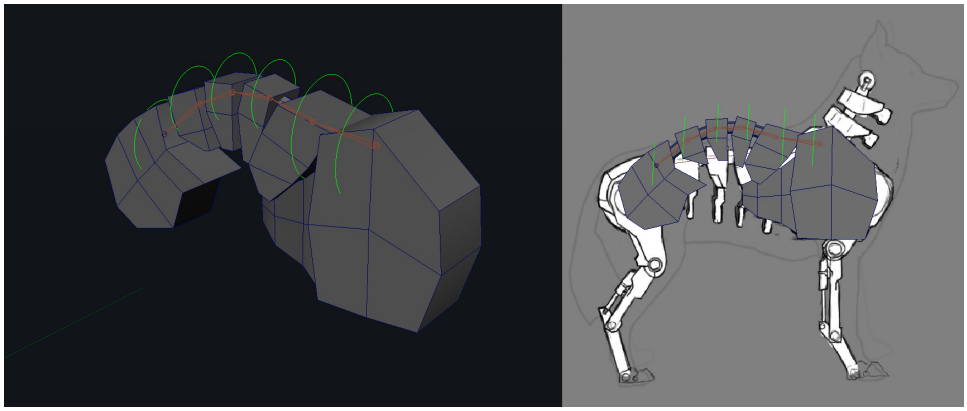


Figure 2.14: Posing of the spine, with anchored shoulder and hips, using IK Splines

Additionally, dogs are digitigrades, meaning they stand and walk on their digits, or toes, unlike humans who stand on the soles of the feet (plantigrades). This can easily lead to confusion in identifying as knees and elbows what are actually an animal's wrist or heel, and the rigging artist must remain conscious of this. Leg controllers, especially IK sys-

tems, must be configured with this in mind (Figure 2.15). Referring back to the research on dog skeletal systems was invaluable at this stage.

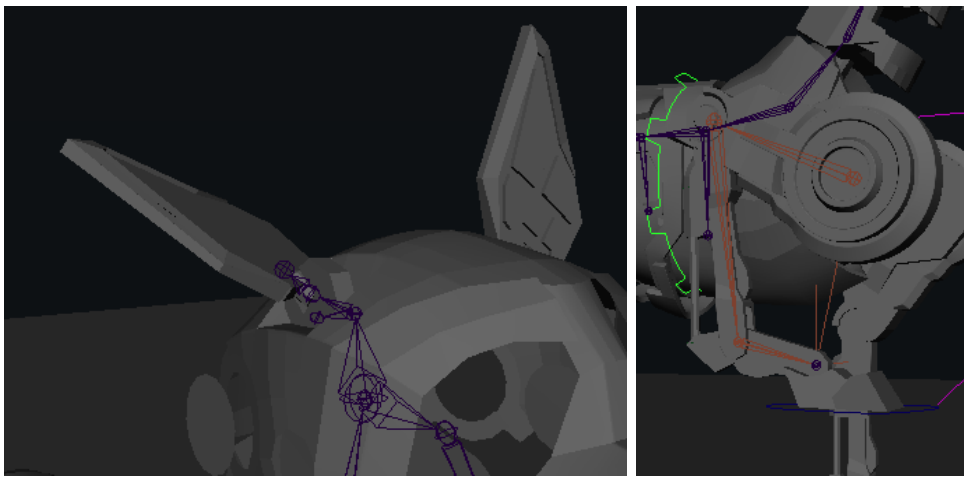


Figure 2.15: Multi-stage mechanical pivot for the ear, and digitigrade IK controls

Subsequently, there are specific challenges of rigging a mechanical character. While the hard surface nature of this design saves the rigging artist time not having to fine tune weight painting, there are many additional considerations this introduces, such as managing and resolving interpenetration of geometry. The character design also consists of many small moving components, such as the vents, hydraulics, eyes, and ears, all of which add to the complexity and quantity of rigging (Figure 2.15).

While I initially made the design decision to keep as much of the body rigid and avoid deformations when possible, as the character development progressed the abdomen began to appear skeletal in comparison to the rest of the body. The gaps between its ribs were too visible, and to extend the plating would potentially complicate rigging to resolve interpenetration and ensure the plate could flex properly. Ultimately, on the suggestion of

the original modeling artist, I chose to connect the rib internals with a flexible carbon-fibre mesh material, which would help fill out the form. While this would need to be deformed for animation, it was relatively simple in nature.

The potential bending and twisting nature of the spine and ribs can lead to some rather unsightly pinching and appearance of lost volume when using traditional linear interpolation deformations. This is often solved with corrective blendshapes or additional structures in the joints. However, some research into *Maya's* different skinning modes, which can be seen in Figure 2.16, led to a viable solution utilizing the dual-quaternion method, instead of the default linear interpolation.

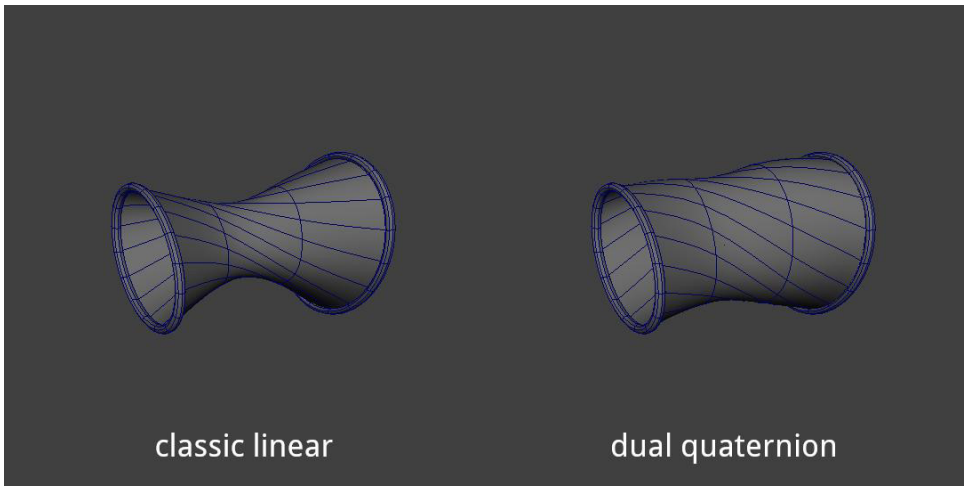


Figure 2.16: Example of pinching in linear skinning mode, while dual quaternion mode maintains volume

2.3.4 Surfacing

Surfacing research was conducted into using Renderman shaders to render photorealistic surface properties. I chose to use Renderman because of my familiarity with it through many previous projects, .

In order to maintain a level of realism that matched my artistic vision, I worked to develop a layered shader system which would emulate the chipping of painted metal surfaces based on wear and weathering maps. Some of these materials are demonstrated on the swatches in Figure 2.17. The final texturing of the character is part of the ongoing scope of the project.

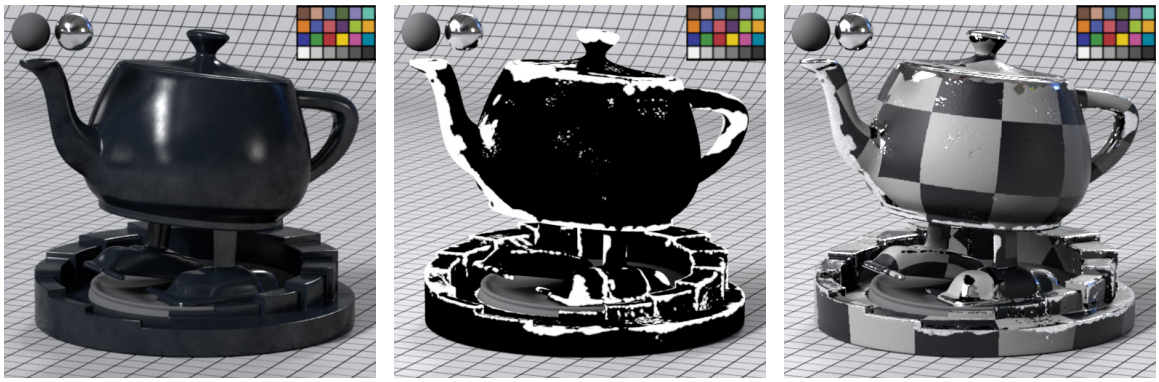


Figure 2.17: Shader development swatches: material, wear maps, and layered weathering

2.4 Props & Costumes

In a live-action film, much of the believability hangs on the props and costumes. While effective props can add flair and enhance the narrative, they can also be one of the most obvious tell-tale signs of a low-budget production. In order to keep the fidelity of the props I would need as high as possible, I chose a to focus on refining a small number of key props.

To create the weapons of *Intercept*, I wanted to create something as physical as possible to make them appear tangible, but also maintain a visual and stylistic consistency. To work within my lack of budget and engineering skills, I used inexpensive Nerf guns as a basis. By creating paintovers in *Photoshop* I was able to determine a color design, using mainly black and white, with accents of blue, as I felt this would be visually cohesive with the designs for the Dog. I felt this would also fit with the concept that the Dog was created by the same corporation that built the weapons.

With these designs, I deconstructed the Nerf guns and painted them. To reduce the pristine feel of the fresh paint, I used a technique called “dry-brushing” to apply chrome paint in light streaks, catching mostly the exposed areas. This gives the impression of wear-and-tear, as it appears that the paint has worn away in those areas, revealing the metal underneath. As I was deconstructing the rifle, I had the idea to implement some practical lighting and give the rifle a more active and functional appearance. I lined the inner frame with some inexpensive blue LEDs I purchased and filled the openings with pieces of frosted acrylic to diffuse the light. This created a very effective glowing effect on

the weapon, which also added a nice practical lighting element to the filming itself. The progress of these stages can be seen in Figure 2.18.

Figure 2.18: Weapon design stages (top to bottom): original, digital paintover, result.

In addition to the weapons I needed to create three additional props, the Thief's data-pad, wrist-mounted Electric Field Generator (EFG) and the mysterious piece of technology which the Thief would ultimately attempt to steal. The completed versions of these can be seen in Figure 2.19.

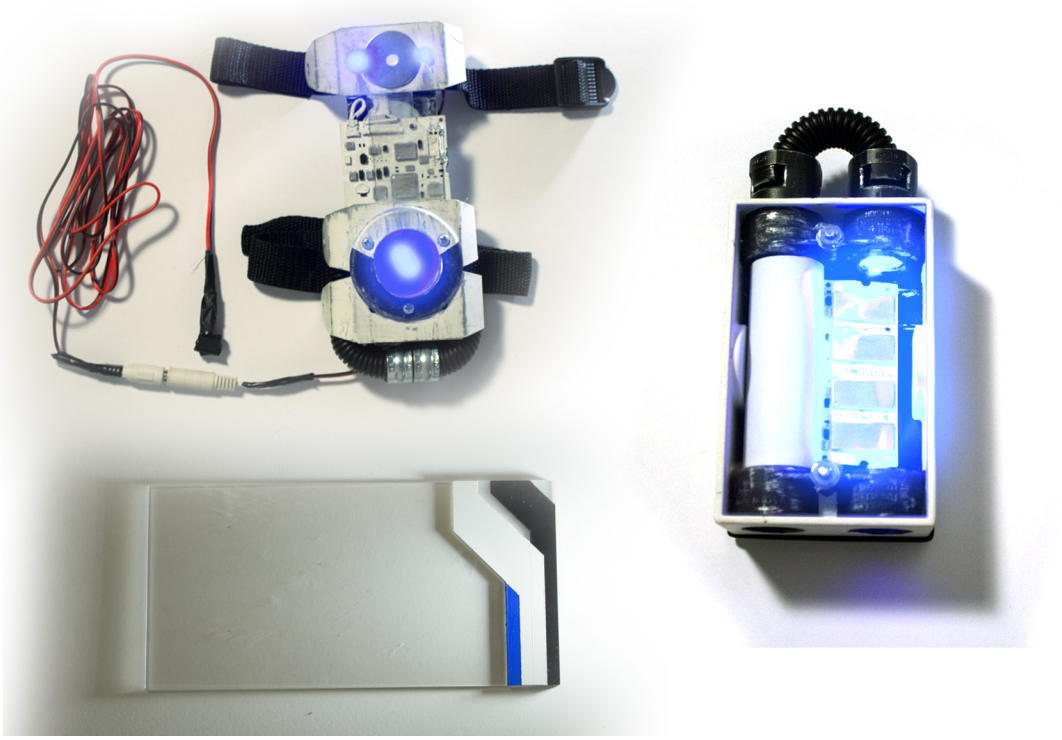


Figure 2.19: Completed props: EFG, data-pad, and mysterious tech

For most of these props, I designed components in Adobe Illustrator, which I was then able to get precisely cut in acrylic through assistance from faculty in the university's packaging science department. The data pad was the simplest prop as it just consisted of a few pieces of acrylic glued together. However, with the other props I also made use of whatever inexpensive hardware supplies I could find. This was a very iterative process, as I would start with an idea of what I wanted, try to find parts that fit closest with that idea, and then rework the designs based on what supplies were available. I wanted to include some practical lighting elements in the props as well, so I set up some basic circuits with LEDs. While not a complex task, integrating the circuitry into the design of the props in a non-obtrusive way was a challenge. While many of the lights were meant to be left on

while filming, I wanted the electrical contact points on the Thief's EFG to be able to flash, indicating ignition. This lead me to designing an extended switch, which could be plugged in and run along the actor's costume. On set, a crew member was then able to stand just out of frame of the shot and flash the light on and off as necessary.

For the design of the piece of mysterious technology, my basic idea was to create something that does not have a distinctly evident purpose. I wanted the audience to view this item as a physical manifestation of the Thief's selfish nature, and not something recognizable beyond that. My initial design started simply as a box, though I still wanted it to be visually interesting and fit in with the general aesthetic of the other props, so I also used pieces of clear acrylic and blue LED's while painting the prop with black and white and weathering it in the same manner as the weapons.

For costuming the characters, I worked along with another student volunteer, Caroline Bryant, to try and find elements of clothing that would fit with the general aesthetic of my development. With regard to the stealthy, rogue nature of the Thief, his costume remained dark, consisting of a hoodie and jacket, with the wrist device contrasting and evoking a futuristic aspect. In general, by setting the narrative as more of a near-future science fiction, the use of contemporary clothing was able to fit well. For the guards, I took more of a utilitarian direction, continuing with the visual themes of black, white and blue, to give them a sense of uniformity. To fill out the guards costumes with detail, I painted and weathered elbow and knee pads, and utilized clips, buckles, and gloves. The final costume designs can be seen in Figure 2.20.

Figure 2.20: The costumes for the Thief (left), and the guards (right)

2.5 Casting

In previous filmmaking projects I have had to rely on myself, classmates, and friends to perform as actors. However, for this project I realized that I had the opportunity to collaborate with real actors. So I approached faculty within the university's performing arts department and through this was provided with guidance on how to structure and manage the auditions, a space to hold them, and was put in contact with the students.

For the auditions I prepared a casting packet which contained the world-building and character background information which I had developed as part of the story exploration process. I also included pieces of concept art to help give an idea of my general vision for the project. The actors were provided two scenes for the audition. The first scene was not from the screenplay, but was a short piece which I wrote as an exploration of the Thief's backstory and motives. This was not something intended to be explicitly exposed to the audience of the short film, but was an exercise in allowing the actor to understand the character, and also for me as a director to see how each actor would interpret the role.

In total, eight students auditioned for the role. I was advised to open the auditions to both male and female students, and received a fairly equal turnout. This expanded my view of how the character that I had written could be interpreted and realized within the film, and influenced the continual development of the work.

Figure 2.21: Still from Chris Berry's audition tape

At the auditions, I used a two camera setup with DSLRs to capture wide angle and close-up shots simultaneously. I then edited the footage from each audition, and reviewed these both on my own, and seeking the advice of advisors and fellow classmates. In the end I selected Chris Berry, the actor that I felt best fit the vision that I had for the project (Figure 2.21). Additionally, I was also able to still work with two of the other actors who auditioned, Christian Stith and Horace Priester, both performing as extras in the roles of the guards, as well as part of the crew.

2.6 Location Scouting

When searching for locations to film, I had to try to stay as close to the university campus as possible. This was because I knew transportation could be difficult and time consuming to organize, even for a small crew, and it was important to save time wherever possible for the actual filming.

With the exception of the opening scene, the entire story takes place in an interior setting. Exterior film locations are subject to many uncontrollable factors such as weather, time of day, variations in lighting across multiple days, etc. With the tight window in which principal photography was scheduled, we did not have the luxury to be able to delay or reschedule filming due to inclement weather. Since the most efficient order of filming is not always chronological, the weather could also pose a problem when editing the film, as there could be noticeable differences in weather or lighting when adjacent shots may be filmed on different days. Another major factor was the time of day. Since the entire crew consisted of student volunteers, all filming had to be scheduled around classes, work and other primary obligations. This meant that there was no guarantee of being able

to work at consistent times over the course of filming. In an interior environment the time of day may not be immediately apparent, and thus will be assumed by the audience based on their only point of reference, which in this case is the opening scene.

Figure 2.22: Scouting photographs of the university's central plant

Even while being indoors, the story of *Intercept* takes place in two distinct locations: the industrial corridors leading in and out of the facility and the server room at its heart. For the more industrial location, I researched industrial complexes in and around Clemson. I attempted to contact as many of these as possible. Ultimately, I was able to coordinate with university's facilities department and was able to schedule a scout of some available locations within the university's central heating and cooling plant. On this

scouting trip I was able to take photographs of various areas within the location (Figure 2.22), and was even provided with floor plans of the building and areas I had been shown. I took this material and reviewed it to determine potential areas in which to film, and plan for any adjustments that may need to be made to the screenplay to better suit the available space.

The second location I was able to coordinate with was the university's offsite data center. This building had a few industrial corridors that would be of good use, as well as a large server room that would serve perfectly for the databanks which the Thief would be stealing information from. As a student, I found that collaboration within university departments and facilities was much more easily organized than attempts with external locations, especially without a dedicated producer to help facilitate those communications. Ultimately, I was very happy with how well the locations fit with my vision for the film.

3 Production

The pre-production tasks all set the groundwork to carry through into production, which involved finding locations to film, procuring all the necessary equipment, and planning and executing the actual filming of the short.

3.1 Equipment

From some of my personal filmmaking projects, I already owned some basic filming equipment such as tripods, dollies, and low-end stabilization rigs such as my homemade fig-rig stabilizer. In the past I have filmed on low-end to prosumer camcorders, though currently I use my own lower-end DSLR, a *Canon* T3i.

Ultimately I believe that any artist can work with whatever tools are available. However, for this project I was curious to explore how I could push my own limits if I had access to some better equipment. So over the course of a month prior to the semester when production was scheduled to start, I launched a *Kickstarter* campaign to crowdfund camera equipment rental (Figure 3.1). I was fully prepared to proceed with filming regardless of the outcome of the fundraising, however, the campaign was a success and I was able to rent a camera, lenses, and a few accessories. In addition to providing financial support, seeing other people interested enough in my ideas to support me, some of whom were complete strangers, was very encouraging to me and provided a huge boost in my own confidence.

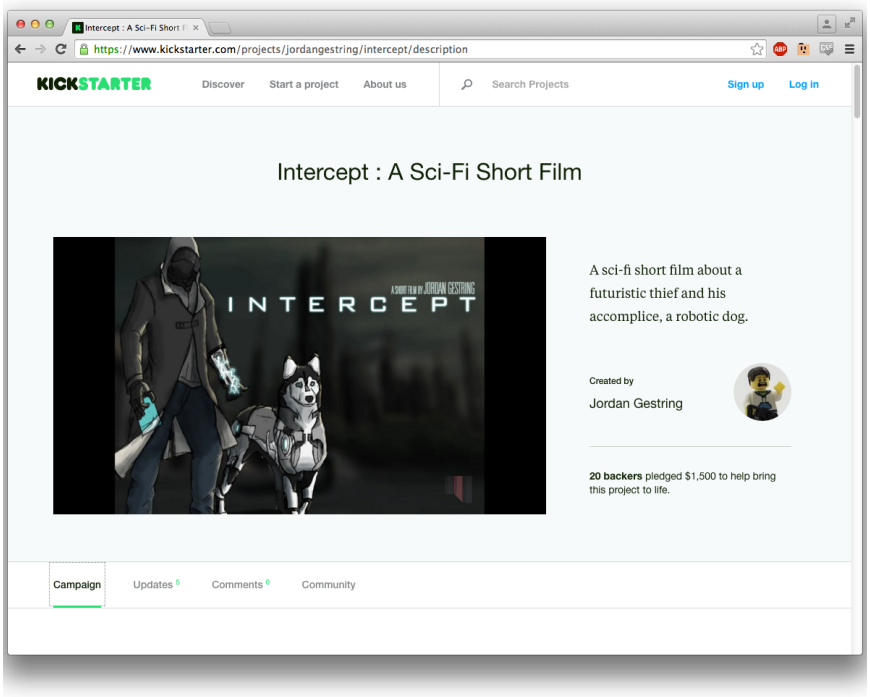


Figure 3.1: The *Kickstarter* campaign page

The camera rented was a *Blackmagic Design Cinema Camera* (Figure 3.2). This model films at 2.5K (2400x1350 pixels) resolution in 12-bit CinemaDNG Raw, resulting in capture of 13 stops of dynamic range [10]. The dynamic range of this format would be an invaluable aspect of post production, as it allows much more flexibility for color correction in post, creating a safety net for any mistakes made on set due to the time or resource constraints, as well as providing a higher fidelity image to work with.

The lenses rented were *Rokinon* cine lenses (Figure 3.2). I chose these lenses because the apertures were large enough to facilitate some of the low-light filming that would need to be done. Cine lenses have de-clicked apertures, meaning the aperture is not limited to the discrete intervals of stops typical of many photography lenses. The rate

at which the controls on these lenses adjust focus are much smaller than most photography lenses, which are optimized for quick auto-focus, and so provide the ability to pull focus much smoothly and precisely. The focus rings are also toothed, allowing them to be utilized natively with follow-focus rigs without the annoyance of needing to attach an external gear ring. A 14mm T3.1 and 35mm T1.5 were selected to provide both a wide and medium lens. I also owned a *Rokinon* 85mm T1.5 Cine lens, which was kept on hand for if a long lens was needed.

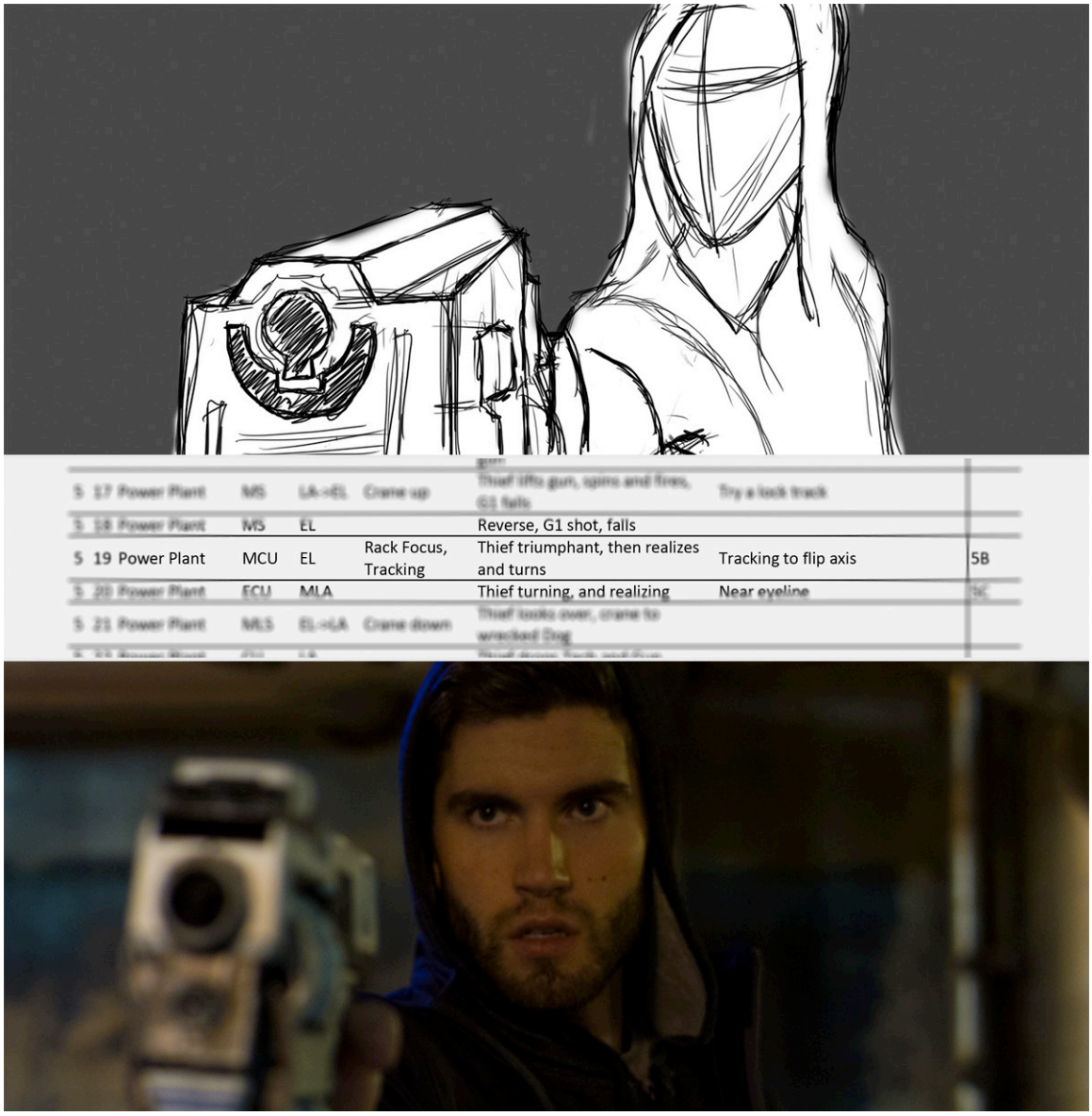
Figure 3.2: The rented *Blackmagic Cinema Camera*, *Rokinon* Cine lenses, and battery

3.2 Principal Photography

Overall the process of filming, also known as principal photography, took place over the course of six individual days spread over two and a half weeks. Each day required transportation of the cast, crew, and equipment to the location, and then setup, such as getting actors into costume and preparing props. As a result, there were anywhere from 1 to 4 hours of total filming time on those days. The tight schedule of available time for filming necessitated as much preparation and planning as possible to make the most efficient use of the time available, to ensure that everything that needed to be captured was before the camera equipment had to be returned.

The first step in planning was the creation of shot lists. From the screenplay and rough storyboards, I progressed through each scene and created a detailed list of each distinct shot. This included information such as the framing of the shot, movement, a brief description (including what characters would be needed for the shot) and any directorial notes. Then I was able to look at a rough overview of the shots and determine a potential order of filming that seemed the most economical. Fortunately, the structure of the narrative meant that, for the most part, shots could be filmed in chronological order. However, there were still exceptions to this, such as organizing some filming so that similarly framed shots were grouped together (to minimize swapping of lenses), or for a particular character's shots to be completed together (to accommodate the actors' availability not always fully overlapping). The progression of this process for a single shot can be seen in Figure 3.3.

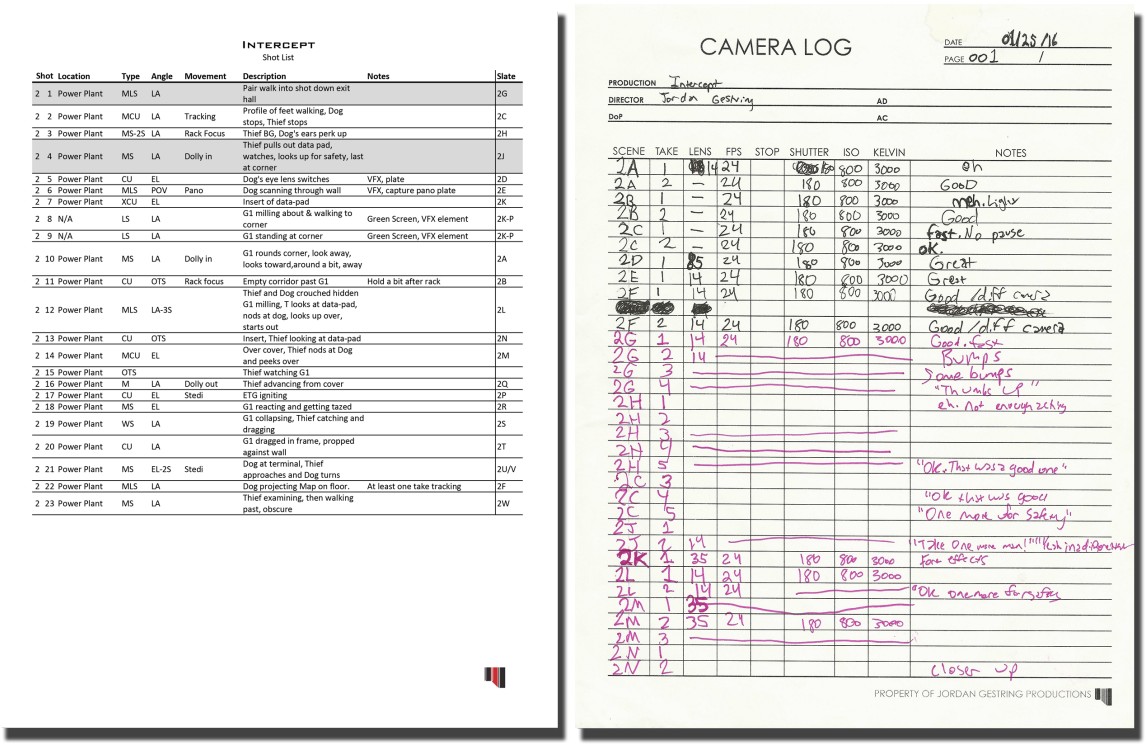
Principal photography requires more teamwork and organization than any other stage of production. The volunteer crew consisted of a production assistant, camera assistant, and one or two additional volunteers to help manage equipment, props and lighting. While this was a small, core group, this teamwork was essential to the successful execution of principal photography.



5	17	Power Plant	MS	LA->EL	Crane up	Thief lifts gun, spins and fires, G1 falls	Try a lock track	
5	18	Power Plant	MS	EL		Reverse, G1 shot, falls		
5	19	Power Plant	MCU	EL	Rack Focus, Tracking	Thief triumphant, then realizes and turns	Tracking to flip axis	5B
5	20	Power Plant	ECU	MLA		Thief turning, and realizing	Near eyeline	5C
5	21	Power Plant	MLS	EL->LA	Crane down	Thief looks over, crane to wrecked Dog		

Figure 3.3: Progression from storyboard, to shotlist, to film

In addition to the shot list, which was generally managed by myself as the director, I also made use of a camera log. This was maintained by the production assistant and allowed a detailed record of not only all shots, but all takes within shots, to be recorded with information such as the lens being used, exposure and shutter information, white balance, and any filming notes (Figure 3.4).



INTERCEPT
Shot List

Shot	Location	Type	Angle	Movement	Description	Notes	Slate
2 1	Power Plant	MLS	LA		Pair walk into shot down exit hall		2G
2 2	Power Plant	MCU	LA	Tracking	Profile of feet walking, Dog stops, Thief stops		2C
2 3	Power Plant	MS-2S	LA	Rack Focus	Thief BG, Dog's ears perk up		2H
2 4	Power Plant	MS	LA	Dolly in	Thief pulls out data pad, watches, looks up for safety, last at corner		2J
2 5	Power Plant	CU	EL		Dog's eye lens switches	VFX, plate	2D
2 6	Power Plant	MLS	POV	Pano	Dog scanning through wall	VFX, capture pano plate	2E
2 7	Power Plant	XCU	EL		Insert of data-pad		2K
2 8	N/A	LS	LA		G1 milling about & walking to corner	Green Screen, VFX element	2K-P
2 9	N/A	LS	LA		G1 standing at corner	Green Screen, VFX element	2K-P
2 10	Power Plant	MS	LA	Dolly in	G1 rounds corner, look away, looks toward,around a bit, away		2A
2 11	Power Plant	CU	OTS	Rack focus	Empty corridor past G1	Hold a bit after rack	2B
2 12	Power Plant	MLS	LA-3S		Thief and Dog crouched hidden G1 milling, T looks at data-pad, nods at dog, looks up over, starts out		2L
2 13	Power Plant	CU	OTS		Insert, Thief looking at data-pad		2N
2 14	Power Plant	MCU	EL		Over cover, Thief nods at Dog and peeks over		2M
2 15	Power Plant	OTS			Thief watching G1		
2 16	Power Plant	M	LA	Dolly out	Thief advancing from cover		2Q
2 17	Power Plant	CU	EL	Stedi	ETG igniting		2P
2 18	Power Plant	MS	EL		G1 reacting and getting tazed		2R
2 19	Power Plant	WS	LA		G1 collapsing, Thief catching and dragging		2S
2 20	Power Plant	CU	LA		G1 dragged in frame, propped against wall		2T
2 21	Power Plant	MS	EL-2S	Stedi	Dog at terminal, Thief approaches and Dog turns		2U/V
2 22	Power Plant	MLS	LA		Dog projecting Map on floor.	At least one take tracking	2F
2 23	Power Plant	MS	LA		Thief examining, then walking past, obscure		2W

CAMERA LOG

DATE 01/28/16
PAGE 001 /

PRODUCTION Intercept
DIRECTOR Jordan Gestring
DoP
AD
AC

SCENE	TAKE	LENS	FPS	STOP	SHUTTER	ISO	KELVIN	NOTES
2A	1	14	24		180	800	3000	Oh
2A	2	—	24		180	800	3000	Good
2B	1	—	24		180	800	3000	meh. Light
2B	2	—	24		180	800	3000	Good
2C	1	—	24		180	800	3000	fast. No pause
2C	2	—	24		180	800	3000	ok.
2D	1	85	24		180	800	3000	Great
2E	1	14	24		180	800	3000	Great
2F	1	14	24		180	800	3000	Good / diff cam's
[redacted]								[redacted]
2F	2	14	24		180	800	3000	Good / diff camera
2G	1	14	24		180	800	3000	Good, fast
2G	2	14						Bumps
2G	3							Some bumps
2G	4							"Thumbs up"
2H	1							eh. Not enough zshing
2H	2							
2H	3							
2H	4							
2H	5							"OK. That was a good one"
2C	3							
2C	4							"OK this was good"
2C	5							"One more for safety"
2J	1							
2J	2	14						"The One more run!" Rushing Process
2K	1	35	24		180	800	3000	Fart effects
2L	1	14	24		180	800	3000	
2L	2	14	24					"OK one more for safety"
2M	1	35						
2M	2	35	24		180	800	3000	
2M	3							
2N	1							
2N	2							closer up

PROPERTY OF JORDAN GESTRING PRODUCTIONS

Figure 3.4: Shot list & camera log

A key organizational aspect of filming was slating the shots. Slating film is the process of creating a visual form of reference in a shot in order to help the editor identify each clip. This is usually done with a clapperboard, or slate, being held in frame briefly as the camera begins rolling, being removed prior to the action of the scene starting. The slate itself contains some useful information about the production, but most importantly

contains the scene, shot, and take information. By holding this in frame as the camera begins rolling, this ensures that the editor needs to only look at the first few frames of a clip, or even simply look at the file's thumbnail, to determine exactly what it is. The slate was usually managed by the camera assistant, but this responsibility had to be handed off at times, depending on crew availability. While a relatively simple and unglamorous task, this proved to be invaluable when it came to editing.

This process also usually involves clapping the "sticks" of the clapperboard together, to provide an audiovisual synchronization point if two-system sound is being utilized. For *Intercept*, I initially attempted to use two-system sound, to simply capture ambient noise and effects (though I had already made the aesthetic and practical decision to not include dialogue), however, after the first day of shooting, it became apparent that the ambient noise in the locations was simply too loud to be able to use any of the sound captured on set, and the decision was made to completely re-record foley for post.

3.3 Cinematography

One of the aspects of cinematography that I wanted to utilize as a storytelling device is the control of screen direction and movement. Within the shots I worked to maintain that progression into the facility, and thus towards danger, occurs from screen right to left, while escaping movement occurs from left to right (Figure 3.5). I utilized framing and the direction of character movement to create a cohesive sense of movement towards and away from danger for the audience, changing direction in moments to reinforce the changes of the narrative.

Figure 3.5: Screen direction and movement into the facility (left) vs out (right)

The pivotal moment for the Thief involves him deciding whether or not to take the mysterious piece of technology. While contemplating, the Thief is facing screen right, indicating his opportunity at safety. However, as see in Figure 3.6, when he chooses to reject the Dog's warning the perspective pivots, not only shifting his screen direction back towards danger, but the movement forces the Dog out of frame, reinforcing that the Thief is turning his back on his companion. When the alarm goes off, and he is caught in momentary shock he is staring screen left, to show the danger he is in, but the Dog's barking breaks through his haze, and draws him back to the right, towards safety.

Figure 3.6: Screen direction indicating shift from safety to danger when the Thief chooses to ignore the Dog's warning

After retreating from the server room, the guard blocking the way is framed screen right of the Thief, visually blocking the him from safety through the composition (Figure 3.7). The Thief is trapped between the danger of the guard and the danger implied by retreating screen left, further into the facility. However he is rescued by the Dog's discovery of the portal, and this reversal of fortune is indicated as the Thief crosses the frame, reversing his screen direction from "danger" back to "safety" (Figure 3.8).

Figure 3.7: The guard framed to the right, compositionally blocking the established direction of safety

Figure 3.8: The reversal of screen direction as the Dog reveals a path to safety

When the Thief again must choose whether to go back for the technology after the fight, his moment of indecision is framed with the exit to his right and the tech to his left, once again reinforcing the dichotomy of choosing between danger and safety (Figure 3.9).

After the Dog is shot, this split of screen direction shifts, and the exit is staged screen left, behind the Thief, with the dying dog screen right. This is meant to indicate that the Thief's only form of safety lies with the Dog, and once he is gone, even the physical exit will not provide him with safety at this point (Figure 3.9). This shift in framing at the end is meant to reinforce the idea that even though the Dog sacrificed himself to help the Thief escape, the loss of the Dog ends up dooming him regardless.

Figure 3.9: The composition of the choice between danger and safety (left) and the reversal of the exit from screen right to left after the Dog's sacrifice (right)

4 Post-Production

The Post Production of *Intercept* is an ongoing work. However, there are many key aspects which I have developed from the initial research and development.

4.1 Editing

As stated in the description of the camera choice, filming in RAW offers a substantial benefit in the freedom in color-correction available in post. This was critical in a project like *Intercept*, where the ability to return and film pickups for shots was practically non-existent. This meant being able to correct mistakes in white balance, exposure, etc. in post production was essential. While this RAW footage rapidly increases storage requirements, storage space is becoming more and more inexpensive, and this size of project makes the penalty manageable. However, this also meant researching the best way to implement a RAW workflow for the needs of the project.

RAW footage formats contain unprocessed sensor data which requires a process called debayering or demosaicing to interpret the data into the red, green, and blue color channels commonly used in digital images. While many editing suites are optimized to manage a RAW workflow, it can be much more efficient to edit using proxy files, and only use the RAW footage for final export. So I am utilizing what is referred to as a "Round-Trip Workflow" (Figure 4.1). *DaVinci Resolve* is used for RAW debayering and a rough "one-light" color correction, and then all footage can be exported in *Apple ProRes Proxy* format. This is easily managed in *Adobe Premiere Pro*, where the editing takes place. Once

VFX plates are determined, those specific shots are exported from *Resolve* as EXR sequences. The edit in *Premiere* can be exported as an Edit Decision List (EDL), which can be brought back into *Resolve*, which replaces the proxy files with the RAW originals. Thus final color correction and export can be done in *Resolve*. With a reliable workflow determined, I proceeded with initial editing.

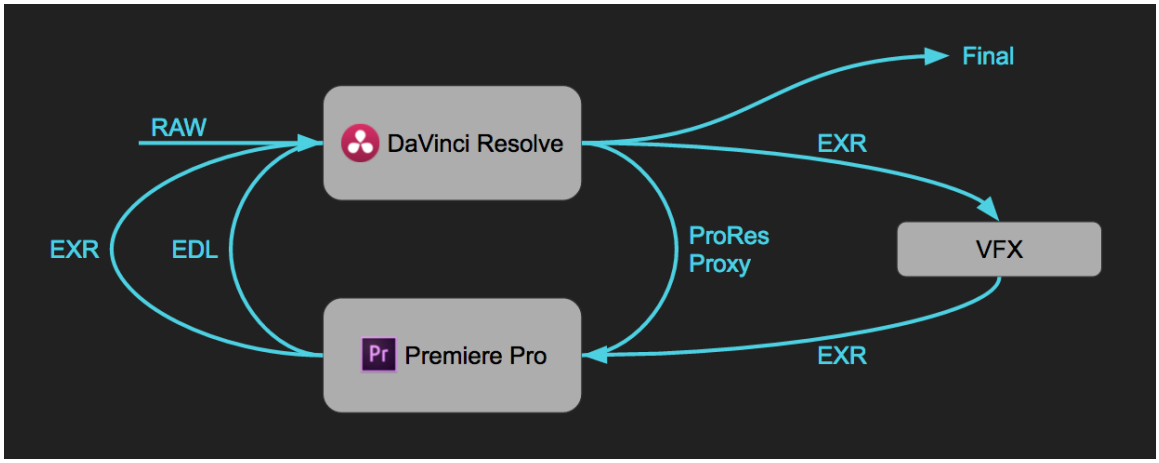


Figure 4.1: Diagram of the "round-trip" RAW workflow

One of the key aspects of editing is organization. While not essentially apparent in the end product, a good organizational workflow can make an immense amount of difference to how an editor is able to spend their time. This is especially applicable in this project where I have many other aspects of the VFX to work on in addition to editing.

This is the point where slating footage really becomes invaluable. Even though, in this case, the director, cameraman, and editor are the same person, slating prevented me from having to rely on memory to organize footage. Within Premiere, I imported all the proxy footage, organized by shoot day. Then by using the shotlists, updated with slate

information, I progressed through each day's footage and categorized the clips into the appropriate scene, shot, and take simply by looking at the thumbnail (Figure 4.2). While this was still a tedious process, it was significantly less time consuming than if I were to have to watch each clip to determine information.

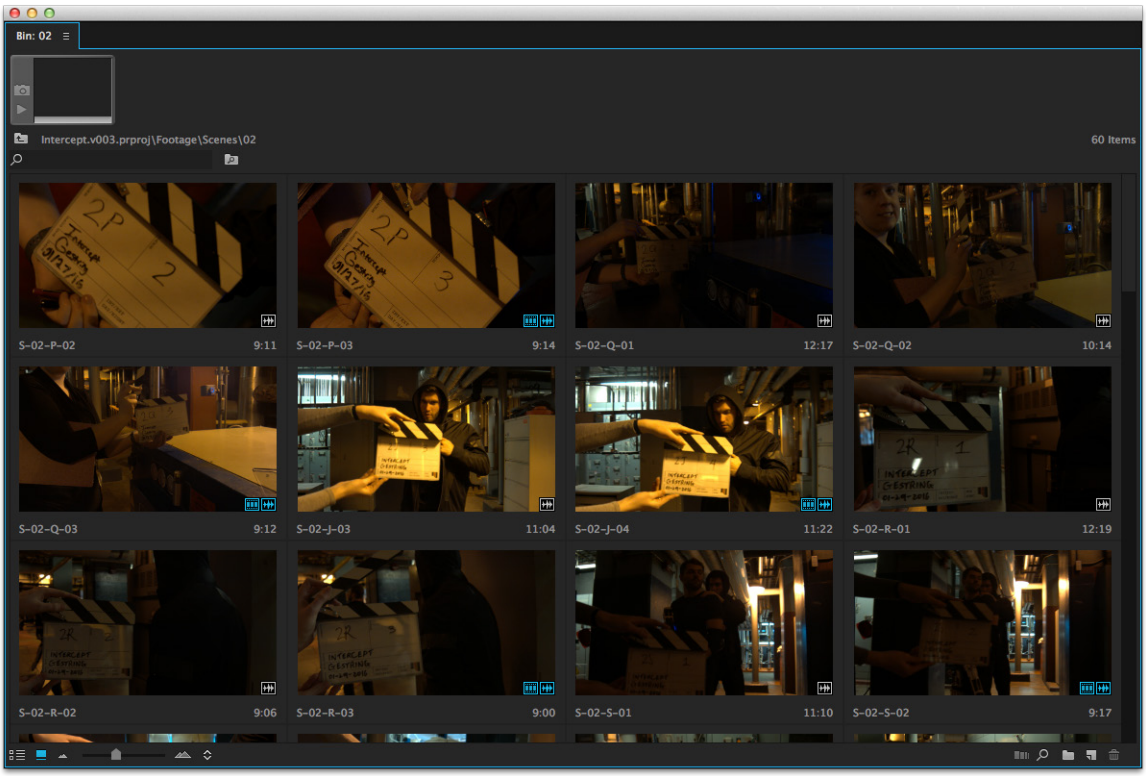


Figure 4.2: Organization in Premiere Pro, utilizing slating visible on clip thumbnails

Once all the footage was organized, the editing workflow was very streamlined. Working with notes I was able to progress through a "rough edit". This consisted simply of walking through each shot, determining the best fitting take or takes (depending on if the shot would be inter-cut with another), and clipping the shot just enough to remove any pre or post-roll. I progressed through the entire short like this, and in the end had a

selection of all the clips that would be used. Next I proceeded with a "loose edit", which involved passing over the full short again, the cuts around shots, being more precise than the rough edit, but not spending the time to fine tune the pacing just yet. After this I progressed through an edit to add placeholder sound effects. This was a very rough process and involved royalty free downloaded sound effects. While not a strictly necessary step, this makes it much easier to review and critique the edit, as in complete silence, cuts and actions can appear much more jarring than they otherwise would without the continuity contributed by sound.

4.2 Animation

As part of the research for the character development stages of the Dog, I researched how dogs interact and move, specifically focusing on two aspects.

The first is general locomotion, such as walking and running. Having already animated a quadrupedal rat in Rats, I was relatively familiar with the movement patterns when walking. However, I still ensured that I had researched dogs and found reference for use as post production proceeds through to animation.

The second is how dogs convey emotion through body language. The two most distinctive aspects of a dog's body language are it's tail and its ears. These are used to convey a wide range of emotions, such at tucking the tail between the legs, and flattening the ears when frightened, or perking up of ears when alerted.

Studying these aspects created a set of references for the post-production to proceed into animation, while simultaneously influencing the development of the rig to ensure these animations would be possible.

4.3 Lighting

A widely-used method of lighting virtual characters, especially for photorealistic projects, is with Image-Based Lighting (IBL), which is the process of illuminating scenes and objects with images of light from the real world [11]. This technique requires the capture of High Dynamic Range Images (HDRIs). HDRIs capture a wide range of exposure without clipping highlight to a maximum value. As can be seen in the Figure 4.3, when the exposure is adjusted, the HDRI has detail in the highlights which is lost in a standard JPEG.

While there are many freely available High Dynamic Range Images (HDRIs) for this purpose, modern film crews will capture their own images from the set, in order be best recreate the actual lighting setup that matches the film plates. While big-budget crews will have intricate equipment to expedite this process, the basic concept is fairly simple, and with patience can be done with fairly simple equipment, and I chose to pursue this for the benefits it would provide in digital lighting.

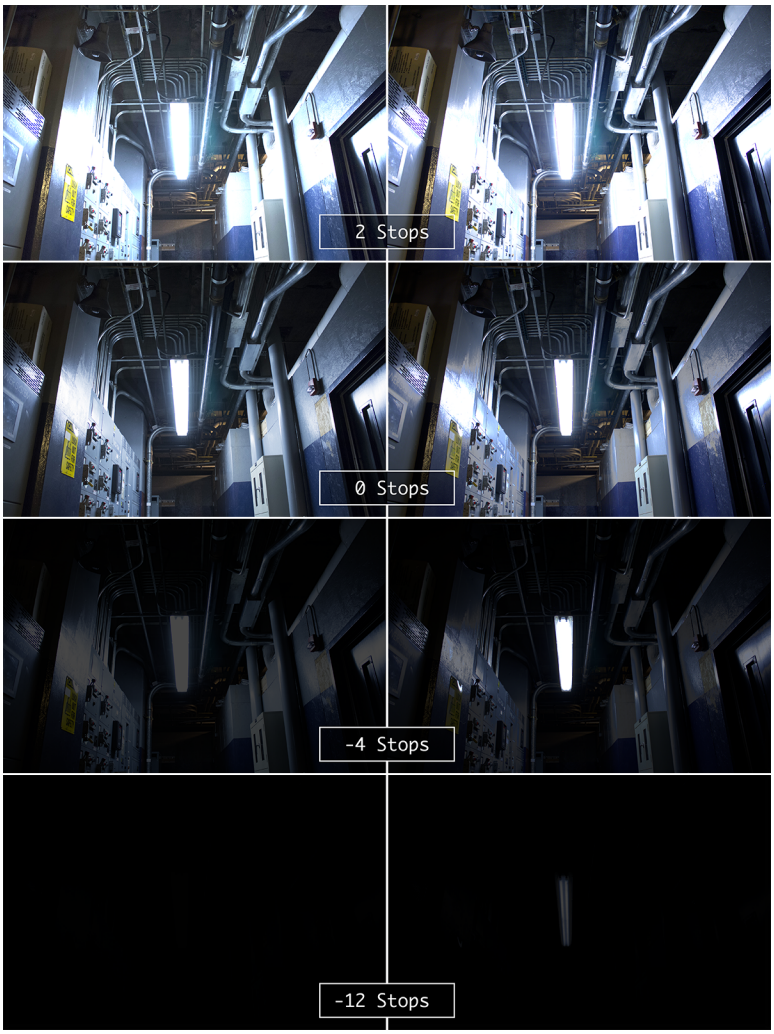


Figure 4.3: Example of information loss when changing exposure in a low-dynamic range JPEG (left) vs. high-dynamic range EXR (right)

After filming had wrapped on two of the shoot days, one at each location, I captures the images to build the HDRIs. By doing this at the end of the day, it did not cut into the scheduled filming time, and did not need to be scheduled with the rest of the crew, as it is essentially a one-man job.

In five different spots across both locations, I used a tripod and my DSLR to capture images in an almost complete spherical panorama. Ideally, the tripod would use a panoramic head, which aligns the pivot axes with the focal point of the camera, eliminating parallax between images. However, the effect of the minor alignment issues this creates are negligible for the purposes of lighting. For each image of the panorama, in order to capture the necessary dynamic range for lighting, I captured in RAW format at four exposure brackets: one evenly exposed, two underexposed, and one overexposed (in steps of two stops of exposure). More underexposed brackets were taken because the detail in the highlights, which is captured in the underexposed images, is more useful for lighting than the detail in the shadows, and ultimately this would conserve space and time overall. *Magic Lantern*, a firmware addon for *Canon* DSLRs, was used to automate the bracketing process.

I used *Photomatix Pro* to combine the bracketed photos. From each set of exposure ranges I created two files, a tonemapped JPEG and full HDR OpenEXR image. While the tonemapped JPEGs are useless for lighting, the detail is compressed into a range that is much more manageable for the panorama stitching software to process than the larger EXRs.

The equirectangular panoramas were then created using *PTGui*. It analyzes the tonemapped images, and through feature detection and matching aligns all the images as best as possible. The effectiveness of this process varies from image to image, though some cases require manual correction through the manual marking of common features between images. When the results were satisfactory, the positioning of the images was saved as a template, which could then be applied directly to the EXRs.

When creating image spheres, some specialized tripod setups can capture images in a full sphere, however with my equipment, I was left with gaps in the zenith, due to the fact that my tripod head cannot aim straight up, and the nadir, which was blocked by the tripod legs. These gaps can be difficult to paint back digitally due to the distortion of the mapping. I resolved this issue by using rectilinear projection to export a cropped image of both the nadir and zenith, which could be brought into *Photoshop*, more intuitively painted, and then reprojected with the final HDRI.

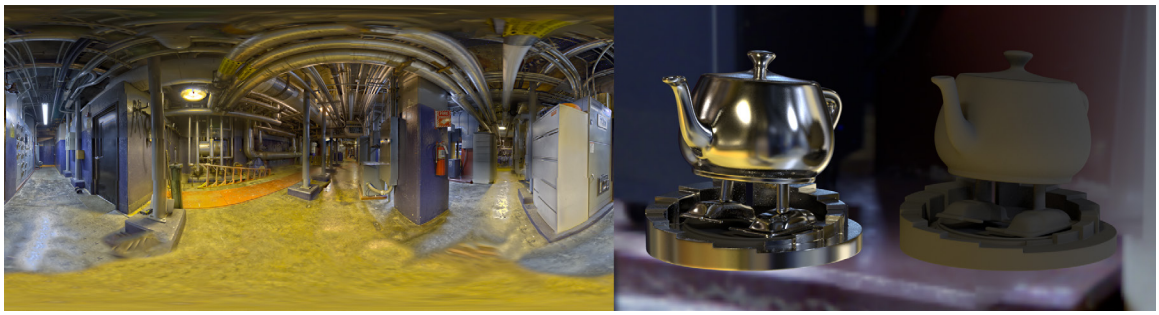


Figure 4.4: IBL result with Renderman using one of the custom built HDRIs

These HDRIs are now able to be brought into *Maya*, and rendered with *Pixar's Renderman* (Figure 4.4). This provides a highly detailed starting point for the animation. By capturing multiple different locations around the set, I have created options for myself, as the lighting artist, based on where each shot is taking place on set, due to the variations of lighting which can be seen in the final five HDRI maps in Figure 4.5.

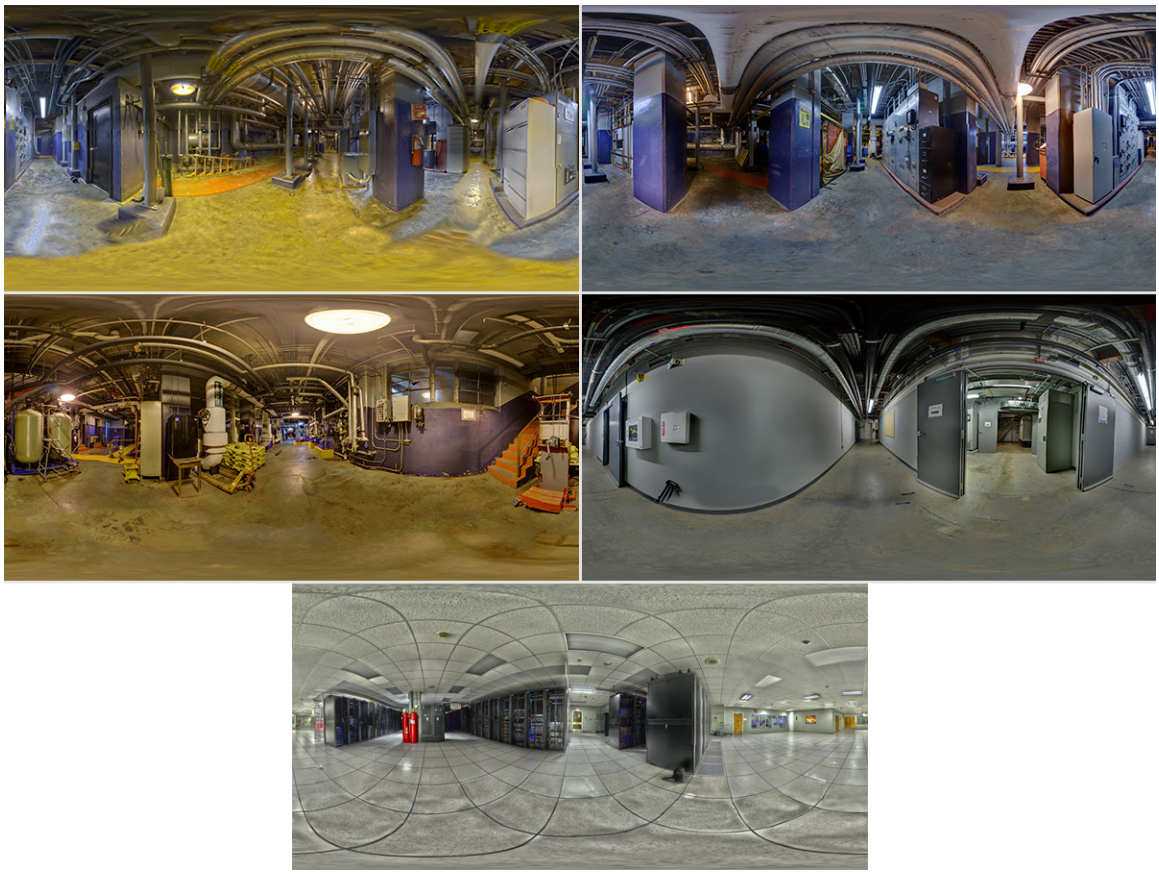


Figure 4.5: HDRIs showing variations in lighting from five locations on set

4.4 Effects

The effects design is an ongoing aspect of development, though initial research was done to determine the general form of certain effects. One of these is the firing effect for the guard's plasma weapons. In order to created a feeling of energy blasts, aspects of this effect are created with layered particle systems. The effect is designed to mimic certain aspects of real gunfire, such as emulating the starred shape of muzzle flashes and plumes of smoke in a manner that feels more like stylized energy (Figure 4.6).

I developed this effect using layered particle simulations within *SideFX Houdini*. Each component of the blast (beam, ring, and flare) is shaped using a seperate simulation and forces. Noise fields are used to achive the wispy appearance of energy. These force parameters are animated over time to control the progression of the effect.

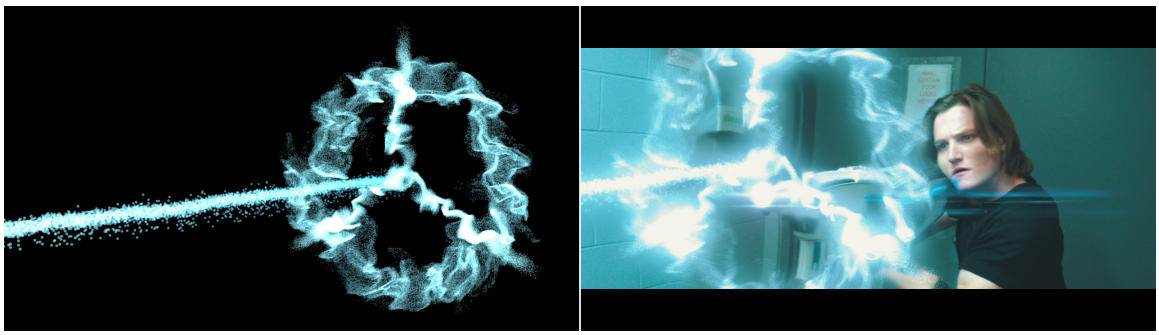


Figure 4.6: Plasma beam effect development

Additional planned effects are the Thief's taser and energy shield, the destruction of the Dog, and motion graphics for the design of the futuristic holographic interfaces and the Dog's sensor vision (Figure 4.7). The electrical and holographic effects are planned to be based on previous projects and effects work I have done: a personal project creating a magical sword formation effect with tendrils of electricity, and the holographic displays and motion graphics which I created for *Rift* (Figure 4.8).

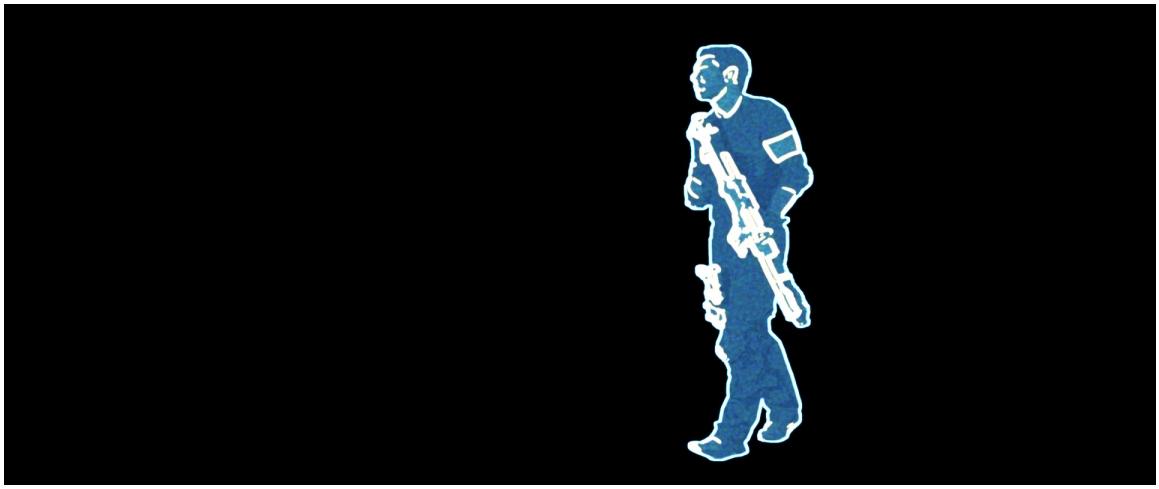


Figure 4.7: Dog's sensor vision effect development

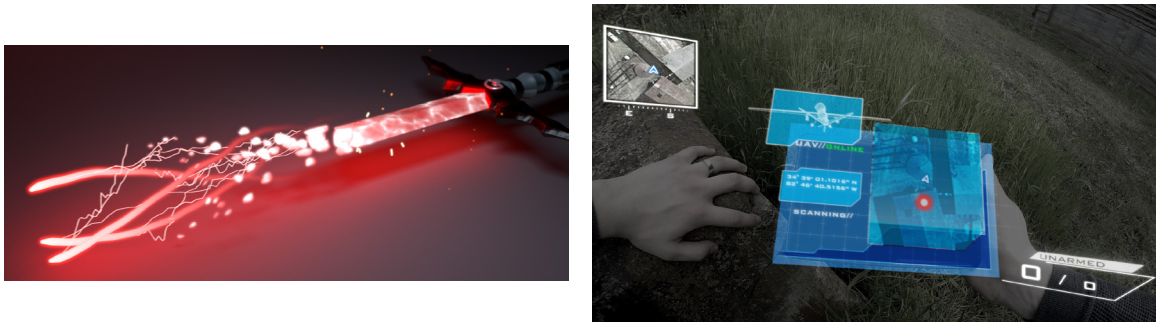


Figure 4.8: Previous work with electrical effects, and holographic displays

4.5 Compositing

One of the most well-known aspects of compositing used in VFX, especially amongst contemporary blockbusters, is the use of chroma-key, or green-screens. Effective green-screen execution requires proper facilities, equipment, and, importantly, physical

space. While I had access to some green-screen facilities, they lacked the space necessary for any but the most basic actions. Due to this, I chose to limit the amount of green screen usage and isolated it to a single effect in two shots: when the Dog uses its scanning sensor vision to locate danger. This also removed some of the pressure of cleaning up the chroma-keyed plates from things such as spill, as the plates would be heavily stylized. However, I still had to be conscious of even lighting and camera angles in order to get a clean key that would match up with the source plates. The breakdown of these results can be seen in Figure 4.9.

Figure 4.9: Chroma key for sensor vision effect: plate, matte, and keyed result

Another aspect of compositing that is only present in live-action projects is matchmoving and tracking. When working on a fully digital project, camera movements and locations in 3D space can be directly accessed in compositing, and as such tracking is almost never necessary. Even in modern live-action filmmaking, advances in technology have provided very precise motion control to record camera movements and use of LIDAR on sets allows capture of accurate 3D positional data. However, with my resource I had to use simpler means, such as matchmoving and tracking.

Tracking is conceptually a fairly simple process, and involves tracking features in 2D footage, and then anchoring composited elements to those points so they appear to

stick to those positions in the scene. Most compositing packages such as *AfterEffects*, or *Nuke* have reliable tracking tool. Matchmoving is the process of using tracked points to solve for the 3D camera movement. This is a much more intensive process, but is necessary for creating camera movements in order to render 3D elements to accurately "anchor" in the scene. While most compositing packages have built-in matchmoving tools, as with UV unwrapping, dedicated matchmoving programs such as *Bojou*, *Matchmover*, *Syntheyes*, and *Mocha* provide much more robust functionality. Figure 4.10 demonstrates the results of matchmoving a free-moving camera shot, with wireframes of overlayed geometry on the floor and walls as well as the Dog model to scale.

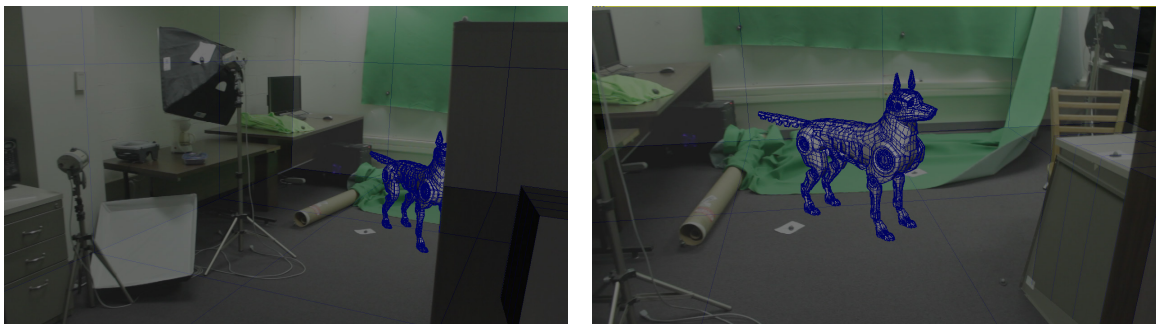


Figure 4.10: Matchmoving with a free-moving camera

Tracking and matchmoving are important because a moving camera can be very effective in facilitating the suspension of disbelief for visual effects. In the same way, artificial camera shake, and lens phenomena such as chromatic aberration, lens distortion, and lens flares are used because they recreate familiar cinematic artifacts and increase the sense of realism.

In order to best manage the challenges of tracking, I chose to take advantage of stationary, and locked-off nodal (tripod) shots when possible. These shots are significantly easier to matchmove than freeform handheld shots, as the matchmove solver can make useful assumptions about the position of the camera. This way I was able to focus on the shots with more complex camera motion as necessary.

5 Results

The pre-production and production of *Intercept* have thus far spanned approximately eight months, and have involved a small cast and crew of student volunteers from multiple disciplines, collaboration with other university departments, and crowdfunded financial support.

In any production, the various departmental tasks are tightly intertwined, each evolving based upon, while simultaneously influencing, each other. While I did collaborate with another student on the 3D character modeling, all other aspects of the pre-production were very much an individual work. While this meant a larger general workload, it also allowed a greater level of artistic ownership over the result.

The crowdfunding campaign gave me an opportunity to pitch my work to the public, and I feel that the success of the campaign indicates my ability to clearly convey my artistic vision and intentions.

I feel that I successfully executed the pre-production in developing and designing all aspects of the short, while also researching and preparing for production. From that I believe the direction of the production was executed successfully, as I was able to organize equipment and locations, and managed scheduling of cast and crew. I believe my direction in the filming process was successful, as the research, planning, and leadership on set enabled a total of 146 shots, comprised of more than 450 total takes, to be captured across the limited window available. Most importantly, all planned shots were able to be cap-

tured. While the post-production is still ongoing, I believe that i have successfully demonstrated what will be created with the groundwork that has been laid.

The following images present a selection of frames from the current edit of *Intercept*:

Figure 5.1: The Thief examines the door to the facility

Figure 5.2: Establishing shot of the futuristic city

Figure 5.3: The Thief and Dog sneak through the corridors

Figure 5.4: The Dog's sensors detect a guard

Figure 5.5: The patrolling guard

Figure 5.6: The Thief knocks out the guard with an electric shock

Figure 5.7: The Thief examines a holographic map

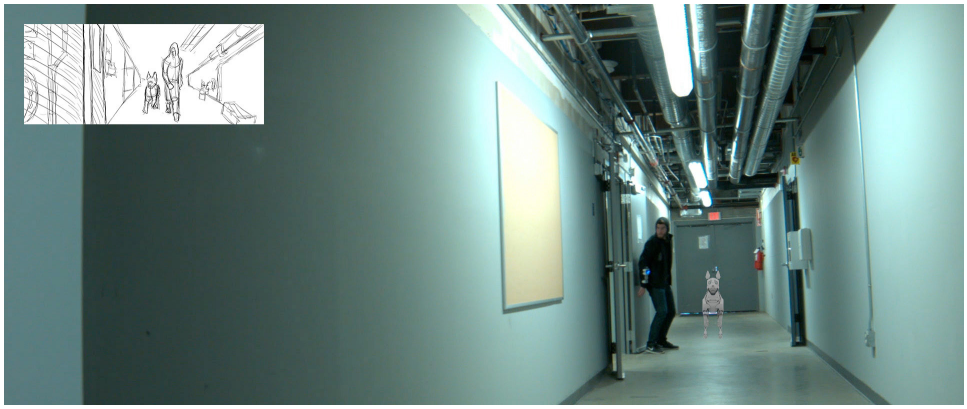


Figure 5.8: The Thief and Dog get closer to their objective

Figure 5.9: Breaking in to the server room

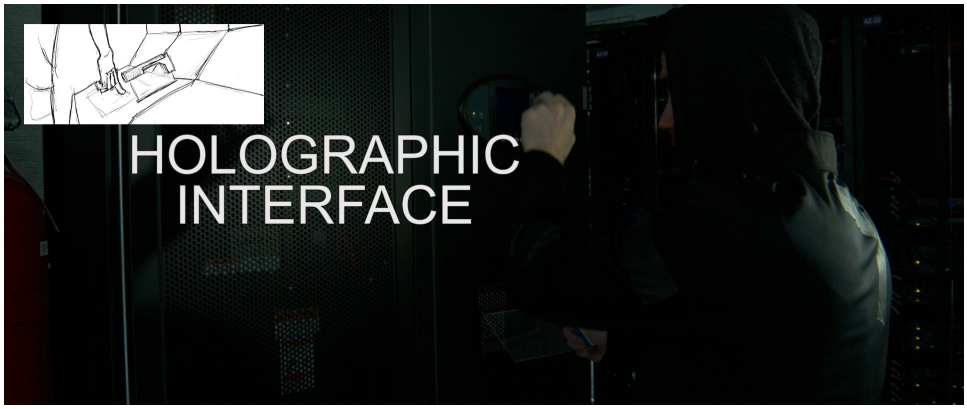


Figure 5.10: The Thief begins to download the data

Figure 5.11: The Thief shares a tender moment with the Dog as he waits

Figure 5.12: Something catches the Thief's eye as he turns to leave

Figure 5.13: The Thief scans the mysterious tech

Figure 5.14: The Thief chooses to ignore the Dog's warning

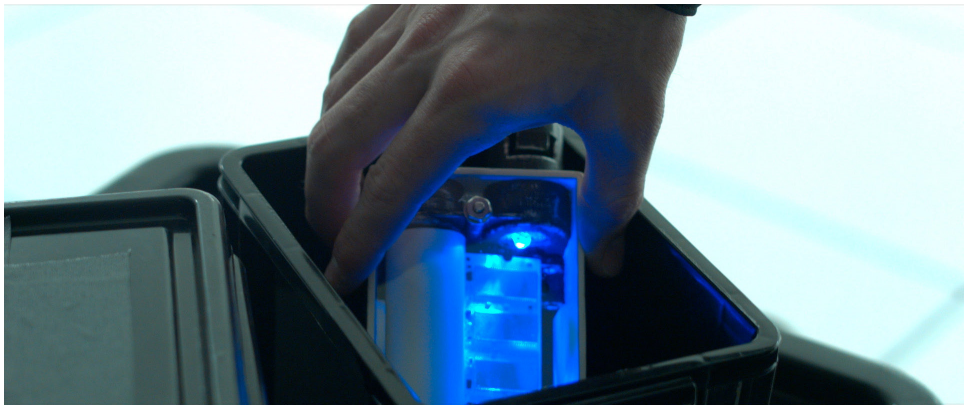


Figure 5.15: Picking up the mysterious tech

Figure 5.16: The alarm send the Thief into a state of panic

Figure 5.17: The Thief is caught off guard as he tries to escape

Figure 5.18: An alerted guard blocks the exit

Figure 5.19: The guard aims down his sights and fires

Figure 5.20: The Thief blocks the blast with his shield

Figure 5.21: Cornered, The Thief turns to the Dog's barking

Figure 5.22: The Dog discovers a portal back to the exit

Figure 5.23: The Thief notices the portal opening back up

Figure 5.24: The Thief ambushes the guard

Figure 5.25: The fight ensues

Figure 5.26: The first guard is roused by a stray plasma blast

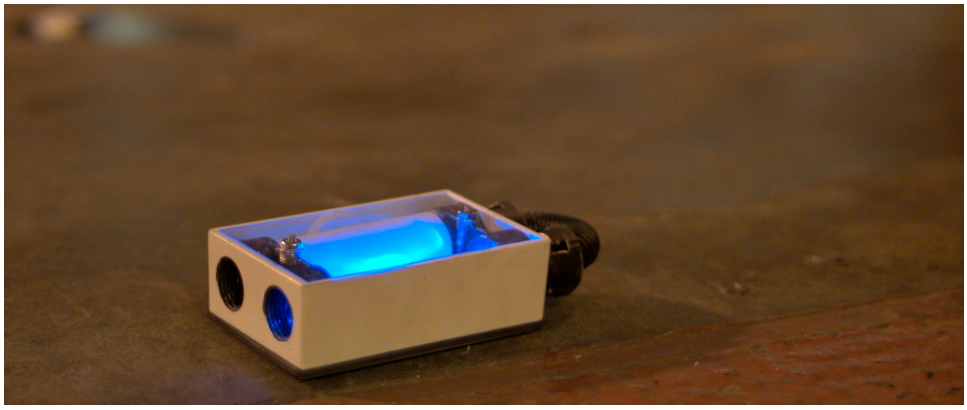


Figure 5.27: In the scuffle the Thief drops the tech

Figure 5.28: The Thief fights for his life

Figure 5.29: The Dog rushes in when the guard is distracted

Figure 5.30: The Thief notices the tech

Figure 5.31: The Thief contemplates his situation

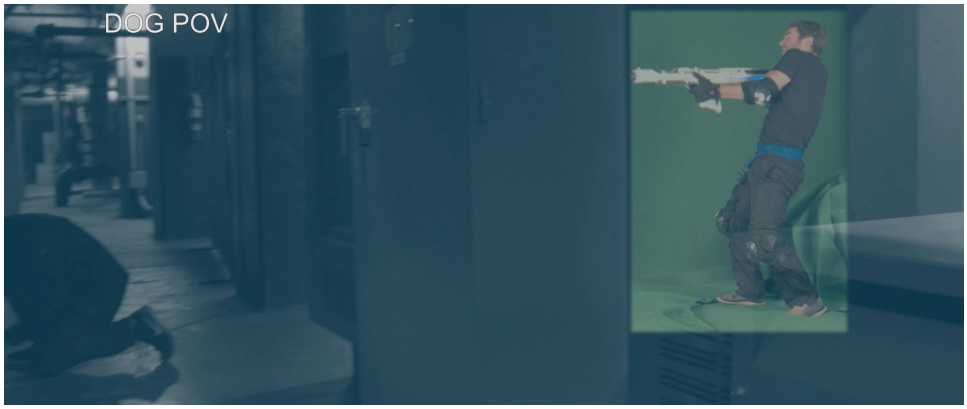


Figure 5.32: The Dog's sensors detect the imminent danger

Figure 5.33: The guard takes aim

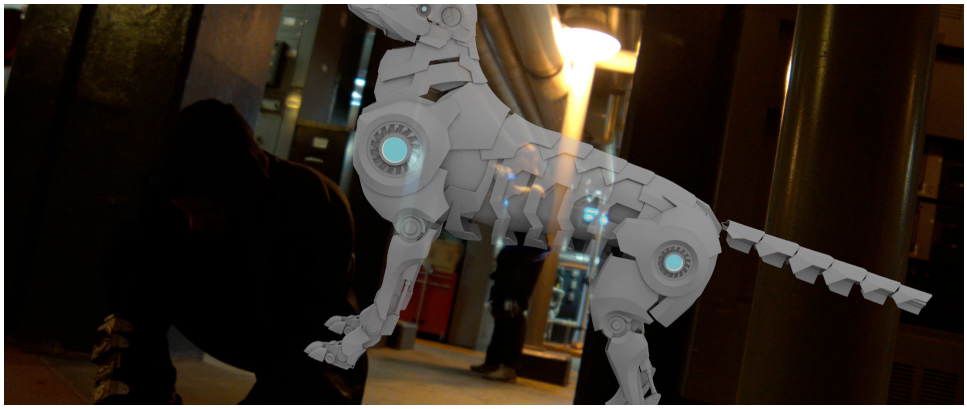


Figure 5.34: The Dog leaps into the path of the blast

Figure 5.35: The Thief shoots his attacker, unaware of Dog's actions

Figure 5.36: The Thief realizes what his companion has done

Figure 5.37: The Thief drops the pistol

Figure 5.38: The Thief rushes to the Dog, but recoils from the sparking damage

Figure 5.39: The Thief gives in to despair

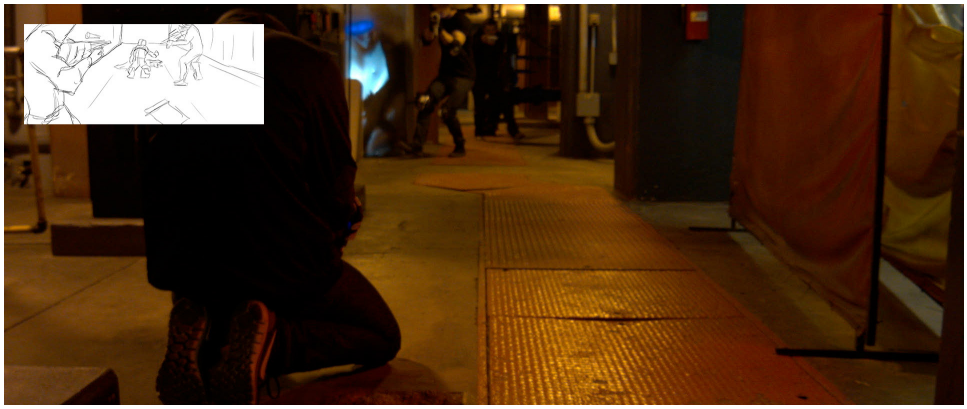


Figure 5.40: More guards move in to surround the Thief

6 Conclusion

Ultimately, *Intercept* is as much a personal work as it is an academic endeavor, and as with any work of art, the result is always different from the artist's original vision. Some of these differences are intentional, when the creative process leads in a better direction than initially planned. However, many of the differences are compromises to the initial ideal form.

From the mindset of a director, I feel like I am constantly thinking of new shots that should have been used, or better ways that existing shots could have been executed. This is one area where I think what will benefit me in the future is simply practicing, and trying new things. Trying out different kinds of shots and ideas, and just seeing what works. For example, I do not think the shots which portray the Thief and Dog retreating through the portal are particularly strong. While I believe the shot I was aiming for could still work, I know that in the future I would need to experiment with multiple ways of filming it, before the actual day of filming.

Managing continuity can be a difficult task for any live-action project, and while a smaller scope means less to keep track of, it also means there are less eyes to help keep track. There was one particular instance on *Intercept* when one of the guards was not wearing his pistol, which was supposed to knocked away for the Thief to use at the end. I only noticed the mistake after about half of the day's filming was done, and at that point it was too late to reshoot, so I had to quickly come up with a story adjustment where the earlier guard could drop the gun; I am still not as happy with the change. In the future, in

addition to the shotlists, I would also maintain a checklist of key props and continuity for specific scenes. Of course, you can never have too many checklists.

Time is probably one of the most critical factors of any project, but at the same time, it is the ultimate motivator. With this project I tried a lot of things for the first time, and while I attempted to plan as much as possible, there are still things that I have learned to do differently in the future. On such thing is that I would attempt to lock down locations as early in pre-production as possible. There were a lot of aspects of the design process which would have been made more efficient if specific details were known about the set. In a similar regard to that, as part of the story development process, I had wanted to film a quick, rough edit using a cell phone or DSLR and stand-in actors. This is a very useful exercise in filmmaking and would have helped explore the cinematography more fully, and also would have been more feasible if location scouting was earlier.

While the visual style of the locations we ended up with was actually strikingly similar to what I had in mind, there are elements of the character and costume design that I wish I would have explored further. With the character, in retrospect, I feel that I would have benefited from exploring the design in more physical media, even through simple sculpture and shaping, to better understand how the 3D forms could fit together. This could have saved a bit of the time reworking designs in 3D, which just physically did not work. For the character costuming, I would have incorporated more graphical design elements, fictional logos, labels, and such to try and add a level of immersion in the fictional world of the story. I would have tried to organize more time with the actor to try on costumes and figure out how they work practically. With some of the props, I just only managed with some luck. For example, I had fit the Thief's wrist-mounted EFG to my

own wrist while building, and while it fit the actor, I had not tested it undergoing a lot of motion and it turned out to be a struggle to keep in place.

For the next stage of *Intercept*, I will be continuing with completing the post-production on the film. Currently, many aspects of *Intercept* have changed from my initial vision, and I know that when it is finished it will have changed even further. But I believe that the most important thing is that every change, whether a mistake or an improvement, has been an opportunity for me to learn and grow as an artist. This understanding encourages me to complete this project, and to take what I have learned and continue to push myself on with new endeavors, to keep creating, and, ultimately, to keep learning.

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